AN INFORMATION TECHNOLOGY PLAN FOR MANAGING THE ENVIRONMENT:

Building a Strategic Infrastructure

Prepared for the
Executive Office of Environmental Affairs

by
Dr. Jerry Mechling
Dr. William Byrn
The EOEA Information Technology Task Force

HAYES-MECHLING-KLEIMAN, INC.

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Hayes–Mechling–Kleiman, Inc.

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June 30, 1987

Hon. James S. Hoyte
Secretary of Environmental Affairs
Executive Office of Environmental Affairs
State Office Building 20th Floor
Boston, MA 02108

Dear Secretary Hoyte:

The attached is the report of your Information Technology Task Force. It outlines a coordinated, multi-agency plan for developing the computer support needed to manage your expanding responsibilities for environmental regulation and clean-up.

As you know, this plan is the product of many people: commissioners, staff, and consultants. The problems we addressed were in part technical and in part organizational.

Our recommendation is for a distributed computing network where some computing is handled on a state-wide basis, some on a secretariat-wide basis, some on a departmental basis, and some at individual workstations. The network recommended will support autonomous local initiatives while also providing EOEA-wide access to database management, geographic information systems, and other tools and talents best provided centrally.

It is a good plan, one whose value is far greater than the sum of its individual parts. It will create value immediately, and also build the infrastructure for yet greater value in the future.

Sincerely,

Jerry Mechling

Jerry Mechling, PhD
Hayes-Mechling-Kleiman, Inc.

Encl.

Acknowledgements

This report presents work of the EOEA Information Technology Task Force. Analysis was provided by external consultants and by the EOEA Data Policy Committee, a standing committee which served as a sub-committee to the Task Force. Rick Taupier and John Shontell served as EOEA project managers.

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(plus members of the Data Policy Committee)

Members of the Data Policy Committee:

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The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and ulitzation of agricultural, mineral, forest, water, air and other resources is hereby declared to be a public purpose.

97th Article, Amendments to the Massachusetts Constitution.

Table of Contents

As but one example, note that Question 4 requires the design, collection, storage, retrieval, analysis, and communication of a large database of hazardous waste sites. These and other needs will not be met by merely expanding existing systems. New needs will require new EOEA systems, and the development of entirely new capacities for database management, geographic information systems, and local and wide-area networking.

The plan we recommend is summarized in Table 1.1. A timetable is provided in Exhibit 1.2 at the end of the chapter; budgetary increments are presented in Exhibit 1.3, with applications by agency in Exhibit 1.4, and a network diagram in Exhibit 1.5.

2. **To expand computerization efficiently, the EOEA and its constituent agencies should organize a network of distributed resources and specialized responsibilities.**

Personal computers and intelligent workstations should be available for individual tasks, with departmental processing for shared local tasks (databases, communications), and with Secretariat-wide and government-wide tools at higher levels in the network (for widely shared databases and highly specialized skills).

Organizing a complex network is a difficult task, but essential. What EOEA should not do is postpone networking (and its access to shared services), or postpone specialization (and its inherent efficiencies).

The network we recommend is diagramed in Exhibit 1.5. Applications by computer location are in Exhibit 1.6.

3. **The costs for expansion will be approximately $2.5 million in one-time costs, and $733,000 per year in recurring costs (mostly for staff).** Outlays over the next two years will be about $2.91 million. External and other support has been identified for significant elements of the program. The total recommended investment is about $700 per EOEA employee.

Such a program is not large relative to EOEA's ability to use the resources productively, nor to spending for technology in other agencies. We believe that the costs are small relative to the opportunity costs of not making the required

Chapter 1: Executive Summary

How much and what kind of computer-based support is needed for the environmental programs of Massachusetts? How should it be organized? How much would it cost and how important is it? These were questions we set out to answer.

In summary form, our answers are straightforward:

1. **To meet urgent and growing environmental responsibilities, Massachusetts needs to more than double its information processing capacity over the next two years.**

"Agenda '90," the recent report of the Senate Committee on Ways and Means, describes the problem:

> "The last 15 years . . . have witnessed the emergence of a new environmental mandate to preserve and protect from toxic contamination or uncontrolled development natural resources which were formerly valued chiefly for their development potential. A more radical shift in governmental policy would be difficult to cite. The ramifications of this shift in policy have been the creation of many new programs, increased focus on state-level as opposed to local solutions to environmental problems, and the sudden involvement of the Commonwealth's environmental agencies in scientific, technological, and economic development worlds that were traditionally foreign to them."

Exhibit 1.1 at the end of this chapter lists the new legislative mandates referred to in the **"Agenda '90"** report.

This growth in environmental responsibilities is driving a growing need for computer-based information processing. Without computer capacity, the complexity of managing the environment may soon become impossible.

investments (costs felt primarily through less effective environmental management).

Table 1.1
EOEA Information Technology Plan

Program Element ----------	One-time	Annual
SECRETARIAT LEVEL = database development, specialized tools		
1. **Stabilize existing applications**	**$232,000**	**$51,000**
- Replace IBM 3031 with 4361-G5	$232,000	$(39,000)
- 3 staff, technical pay scale	n/a	90,000
2. **Expand EOEA Data Center hardware**	**909,000**	**171,000**
- DEC VAX 8500** (80 users)	909,000	81,000
- 3 staff, training	n/a	90,000
3. **Install and support databases**	**570,000**	**160,000**
- on VAX (ORACLE or equivalent)	90,000	10,000
- 2 staff @ EOEA	n/a	60,000
- 1 staff ea. @ DEQE, MDC, DEM	n/a	90,000
- contractors: DEQE File, etc.	480,000	n/a
4. **Continue and expand GIS development**	**300,000**	**30,000**
- 1 staff @ EOEA, contract work	300,000	30,000
5. **Develop and monitor I-T plans**	**80,000**	**n/a**
DEPARTMENTAL LEVEL = office automation, end-user support		
6. **Expand departmental hardware**	**402,000**	**119,000**
- DEC VAX 8200**	292,000	34,000
- 2 operations staff	n/a	60,000
- MicroVAX II @ 100 Cambridge	60,000	20,000
- LAN @ MDC	50,000	5,000
7. **Install office automation (260 users)**	**70,000**	**34,000**
- word processing, e-mail, etc.	70,000	4,000
- 1 OA/LAN support staff at EOEA	n/a	30,000
8. **Accelerate PC growth, user support**	**n/a**	**168,000**
- 20 PCs/year above present rates		100,000
- 2 staff at EOEA Data Center	n/a	60,000
Strategic I-S Infrastructure	**$2,563,000**	**$733,000**

** Equipment models are meant to suggest approximate size and the importance of a uniform processing environment supporting applications emphasizing interactive end-user analysis; models listed here do NOT represent a decision on the final vendor.

The remainder of this chapter describes our study. After examining the EOEA's growing need for information and usage of computer-based technologies, we present the elements of our proposed plan. We conclude with a summary of benefits and costs and the need for coherent implementation.

1.1 GROWING NEEDS FOR INFORMATION

The EOEA faces large and growing responsibilities for environmental management. As described in the "Agenda '90" report, these include hazardous waste cleanup, facility siting, land use and open space management, implementation of the Water Management Act, and others.

For all these problems, effective management requires access to information and communications. Environmental police officers in Boston Harbor, for example, need access to boat registrations much as the MDC police need car registrations and other on-line files; to be without such access from the field is inefficient, even dangerous.

As another example, enforcement officials in DEQE's regional offices often need records held centrally in Boston or expertise from their peers in other regions. At present, however, such access is often impossible. Far too much time is wasted in maintaining and searching for the facts and precedents needed to decide an individual case. We have reached a point where cases are decided late, inefficiently, and/or inequitably, simply because of our inability to share data and expertise.

Problems with information access are not new, of course. Information has always been essential to control of all types. Any organization which can't find the information required for operational feedback and direction-setting is flying blind.

What is new is the order of magnitude. Needs for information and control have been growing enormously in the past twenty years. This growth continues today and, for the EOEA, has pushed up the systems-related proposals (AF29s) from 25 three years ago to 124 last year (nearly a four-fold increase, the highest growth rate in the state). (Exhibit 1.7 summarizes EOEA's ADP initiatives in fiscal years '85 and '86.)

As one of many examples driving this growth, consider that, under the Right-To-Know system, the DEQE must maintain data on some 600,000 material safety data sheets filed by 120,000 different sites. Access to this data base, which resides at the EOEA Data Center, is unreliable due to poor communications systems and an antiquated IBM mainframe incapable of such an application. If an emergency such as a fire or spill occurs, the relevant data are not accessible. This is so even though compliance at present is only in the range of 5-10 percent. Better systems are needed.

What is also new is the complexity of environmental decision-making. Environmental problems involve coordination among a variety of experts and expertise. Returning to the hazardous waste example, an appropriate field determination on an individual site may require judgments and trade-offs from the fields of toxicology, chemistry, geology, demography, climatology, and environmental engineering. Such complexity means that environmental programs, perhaps more than most governmental programs, need detailed and flexible access to information and expertise.

Exhibit 1.8 presents a simplified tabulation of selected environmental programs and their needs for information technologies. At EOEA today, most of these needs remain unmet.

1.2 THE STATUS OF EOEA INFORMATION TECHNOLOGIES

Information technology can be an important tool for better management of the environment. To assess opportunities at EOEA, we compared usage here with that of other organizations, public and private, in Massachusetts and elsewhere. We looked at applications supported and the kinds of organizational learning and skills required.

Basically, there are three major benefits of computer applications:

1. **Efficiency.** Properly applied, computers lead to efficient record keeping, allowing data to grow without a proportional growth in staff. The EOEA can thus use computers so that clerical and other operations can be handled more efficiently.

2. **Effectiveness.** Computer-based tools can also improve the effectiveness of work, especially for professionals. Thus, for example, EOEA field engineers can produce better analyses because of the time saved in assembling data, and also because tools such as Lotus 1-2-3 and specialized environmental models support more sophisticated analyses.

3. **Transformation.** In some cases, computers go so far as to transform individual jobs or services. This has happened with airline reservation systems and hospital supply ordering systems; in these private examples, market share has shifted dramatically to firms with better computers. In government, computerization is also capable of transformational change. This is occurring, for example, with fingerprint retrieval systems that allow prints to be used in searching for new suspects rather than merely confirming the identity of suspects already apprehended. It may also happen with the Federal EPA where investments are being made in "expert systems" for the kinds of hazardous waste field evaluation problems mentioned earlier.

On the range of such applications, where does EOEA stand today? To be brief, present applications are overwhelmingly oriented to efficiency, and not to effectiveness or strategic transformation. EOEA's are the traditional applications, those almost always implemented early in an organization's experience with computers.

So far, EOEA has been getting modest benefits from a very modest investment in information technology. For the future, we recommend building the technical and organizational infrastructure needed for much bigger benefits. We need a network of computers and computer-skilled people.

To make such a program work, however, it must be understood that what is involved is not an overnight purchase of something "off the shelf". The essence of our program is the buildup of new telecommunications "highways" along with the skills required to handle the new "traffic"; the traffic itself will be the databases, geographic information systems, and improved communications needed for environmental regulation and clean-up. What we recommend will create important near-term benefits, but is especially important as a strategic long-term investment.

1.3 PROPOSED DISTRIBUTED PROCESSING SYSTEM

In developing our proposal, we looked at many alternatives. We analyzed applications, evaluated how fast EOEA as an organization could learn and change, and considered alternative ways to organize jobs and the communications network.

The proposal we eventually developed has the following major activities:

1. **Expanding traditional mainframe and personal computer applications and support.** This will support pending requests for record-keeping systems. It will add about 90 personal computers per year for use by professional and clerical staff. (Note, for example, that some 170 of the MDC staff are used primarily for typing and have, at present, absolutely no access to word processing; there are only 5 personal computers available for 1700 MDC employees.)

This element of our proposal will be relatively "easy" to implement. It will return direct benefits and also develop skills needed for the rest of the program.

2. **Introducing networking, database, and geographic information system tools.** The network we propose will add to the capacities of the existing mainframe-based network and will connect all EOEA agencies; we plan within the next two years for some 260 work stations to be able to share computing resources and communicate via electronic mail.

The relational database (RDBMS) to be selected will be accessible to these work-stations through the EOEA Data Center. It will be used, with assistance from outside contractors, to construct the DEQE Facilities Master File (and other database applications required by Question 4); it will also be available to EOEA staff, with assistance from staff to be hired and trained for end-user support, for analyzing and sharing EOEA data.

Geographic Information Systems deserve continued and expanded support for design and early implementation work. GIS are the tools which, as an enhancement to an RDBMS, make it easy to analyze and update geographically-oriented data. GIS are perfect for tasks such as identifying parcels to acquire under the Open Space Management Act. Some 90% of EOEA's databases are geographically oriented.

Working with the United States Geological Survey, the EOEA has begun GIS projects on geology, acquifers, drainage basins, hydrography, public wells, waste sources, and the transportation network. As these and other databases come on-line, the GIS will be effective inside EOEA and also in communicating with community groups and others on issues best understood through maps. In addition to proposed GIS efforts, the EOEA has begun CAD (Computer Aided Design) initiative which will aid EOEA engineers and inter-agency projects. In many cases, the GIS and CAD efforts will be able to exchange information and benefit from each other.

Networking, database, and GIS tools represent new capacities for the EOEA. Their impact will be strategic, but we must first construct the technological and organizational infrastructure. That is the purpose of our plan.

3. **Acquiring the hardware capacity to handle the new workload.** We propose immediate replacement of the IBM 3031 with a more reliable and cost-effective 4361. This will:

-- reduce maintenance by $39,000 per year

-- improve reliability for existing applications

-- give time for management to digest new responsibilities (instead of fire-fighting the forced conversion of old IBM applications)

We also propose investing in new systems to support office automation, analytic, and, for the future, potentially significant GIS workloads. These are sufficiently different from our present transaction processing workload that we have costed out the new systems in terms of the offerings of the Digital Equipment Corporation.

This does NOT mean that DEC should be the vendor of choice. It does mean, however, that **we recommend the selection and acquisition of a uniform processing environment, one oriented to the workload of the future rather than that of the past**.

In particular we recommend a machine of the scale and character of a DEC VAX 8500 for the EOEA Data Center. This will run the relational database management package and other development software. It will also expand the capacity of the EOEA Data Center by nearly 200%.*

For departmental computing we recommend:

-- a machine of the scale of a DEC VAX 8200 at DEQE (limited in the first two years to office automation and a local area network for communications within 1 Winter Street)

-- a machine on the scale of a DEC MicroVAX II to service a local area network for the EOEA Secretariat and departments located at 100 Cambridge Street.

4. **Adding the staff needed to make it all work.** The program we propose will not work without new staff and new skills.

Specifically, we recommend seventeen new staff in total with twelve at the EOEA Data Center. These Data Center staff are required for the new systems, the new network, the expanded PC user base, the new database environment, and, later in the program, for the new geographic information systems. They represent an expansion of Data Center staff by about 80%.

With the EOEA Data Center specializing in database and network support, the departments will specialize in "vanilla" office automation and end-user support. We recommend two operations staff for the DEQE along with one analyst for DEQE, one for the MDC, and one for DEM. In the future, we expect that other departments will also need their own technical staff, and that departmental computing will expand to areas such as in-house database development.

We also recommend that substantial work be contracted to consultants. This will help keep pace with time requirements -- (e.g., for the Facilities Master File and

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* We estimate that 20% of this growth will come from converted existing applications. Another 15% will come from applications not yet identified. The remaining 65% will be driven by database management applications, through end-user analysis of existing data (as in the Right-to-Know and the Hazardous Waste Manifest System), and through new applications such as those for Question 4. See Chapter 2 section 2 for further explanation of this estimate. (Note that GIS, when brought in-house, will require a yet further expansion in EOEA computing power.)

work on Question 4 at DEQE) -- and/or acquire specialized skills (e.g., for geographic information systems).

1.4 BENEFITS AND COSTS OF THE PROPOSED SYSTEM

Our proposal holds promise for a strong return on the investment.

1. **The costs are relatively low.** Annual costs are about $730,000 per year, with a one-time cost on the order of $2.5 million. This is less than 1% of the overall EOEA budget and low in comparison with computing in other large public and private organizations.

The approach we recommend -- specialized roles within a distributed network -- is the most efficient way to expand capacity. (For a summary of costs by resource type, see Exhibit 1.9.)

2. **There will be benefits through cost avoidance and revenue enhancement.** In general, the EOEA is hugely over-reliant on manual methods. It is impossible for present methods to be efficient, and becoming impossible for agencies to keep up with reporting and record keeping requirements.

While computerization will largely avoid costs rather than reduce them, the savings potential is important. In some cases -- as has occurred with fee schedules in the Department of Agriculture -- revenues will expand to more than pay for computerization even within the first year of the program.

3. **Most importantly, there will be benefits through better management.** The environment presents many issues which cannot be managed effectively without vastly better access to data and communications. Under Question 4, we must organize and implement a program involving some $250 million in total expenditures over the next several years. Failing to invest in information and communications would hinder our ability to meet the stringent requirements involved.

* * * * *

What we propose is an investment in information technology to keep pace with urgent and growing environmental programs. It is a relatively small investment, with sizable returns. It is a coherent investment, strongly supported by the EOEA Secretariat and its constituent departments. It will help build the management infrastructure of the next 15 years and should be implemented immediately.

Exhibit 1.1
Recent Massachusetts Environmental Legislation
(adapted from "**Agenda '90**" report)

ACTS OF 1983	
Chapter 7:	Massachusetts Oil and Hazardous Material Release Prevention Act.
Chapter 167:	Further Regulating the Law Relative to Water Pollution Control and Water Supply and Conservation.
Chapter 589:	Protection of Massachusetts Coastline.
Chapter 606:	Board of Certification of Operators of Wastewater Treatment Facilities.
Chapter 723:	Open Space Capital Outlay Budget.
ACTS OF 1984	
Chapter 233:	Capital Outlay Program.
Chapter 372:	Massachusetts Water Resources Authority.
Chapter 472:	Grant Program Within the Department of Environmental Quality Engineering to Remove Infiltration and Inflow From the Sewerage System of Towns, Cities, and Sewerage Districts.
ACTS OF 1985	
Chapter 95:	Imposing Administrative Penalties for Environmental Violations.
Chapter 590:	Limiting Acid Rain and Acid Deposition on Massachusetts.
Chapter 592:	Massachusetts Water Management Act.
Chapter 786:	Water Pollution Control and Water Supply Conservation.
ACTS OF 1986	
Chapter 10:	Massachusetts Hazardous Waste Insolvency Fund.
Chapter 554:	Cleanup and Emergency Relief at Oil and Hazardous Material Disposal Sites.
PENDING	
Senate 979:	Relative to the Protection of the Environment Through the Regulation of Storage of Oil and Hazardous Materials in Underground Storage Tanks.
Senate 1694:	Authorizing Public Right-of-Passage Along the Coastline of the Commonwealth.
Senate 1716:	Providing for the Management of Low-Level Radioactive Waste.
House 1577:	Create a Special Commission on Growth and Change in the Commonwealth.
House 2130:	Providing for Timely and Effective Clean-up and Emergency Relief at Oil and Hazardous Material Sites in the Commonwealth.

Exhibit 1.1
Recent Massachusetts Environmental Legislation
(adapted from "Agenda '90" report)
(continued)

House 5177:	Providing for an Environmental Enhancement and Protection Program for the Commonwealth.
House 5230:	Relative to the Management of Solid Waste and the Abatement of Pollution Resulting Therefrom.
Various:	Providing Land Banks for the Purpose of Acquiring and Managing Open Space and Conservation Land in Certain Municipalities.

Exhibit 1.2
EOEA Information Technology Timetable

ACTION	FY'88 1	2	3	4	FY'89 1	2	3	4
Stabilize existing applications								
Replace 3031 with 4361-G5	X		X					
Hire EOEA I-T Manager, 2 analysts	X		X					
Implement technical pay scale		X						
Prepare RFP for 'integrated environment' (Hardware, Database, Office Automation)	X		X					
Staff for new environment								
EOEA operations - 3 systems staff				X				
EOEA DBMS - 1 DBMS administrator, 1 analyst			X			X		
EOEA OA/LAN - 1 OA/LAN specialist			X					
EOEA PC Support - 2 support staff	X				X			
EOEA GIS work - 1 specialist							X	
DEQE - 2 operators, 1 DBMS staff			X		X			
MDC - 1 end-user PC/DBMS staff					X			
DEM - 1 end-user PC/DBMS staff					X			
Acquire and install new HW/SW (RDBMS, OA)			X			X		
EOEA and DEQE								
MDC and 100 Cambridge								
Prepare RFP for initial RDBMS applications			X	X				
End-user support expansion for PCs, OA	X				X			
Expand GIS development			X				X	
Revise and extend I-T strategic plan	X				X			

Exhibit 1.3
Recommended Distributed Network

I. ACTIONS

HARDWARE AND SOFTWARE

- IBM and intelligent Switch at EOEA Data Center
- Central VAX 8500 for large databases
- Distributed VAX support of office automation at DEQE (8200) and at 100 Cambridge Street (MicroVax II)
- PCs at departments

STAFF AND GOVERNANCE

- Staff expansion and training at EOEA, Data Center (12)
  - EOEA IT Manager
  - Staff for operations, network support
  - Staff for End-user DBMS, development
  - Staff for Network and PC support
- Staff expansion for departments (5)
  - 3 @ DEQE for operations, database, contractor oversight
  - 1 each @ MDC, DEM for database, end-user support
- Contract work:
  - DEQE Facilities Master File
  - DEQE Question #4 work
  - GIS feasibility, experimentation
  - Other?

USER CAPABILITIES/RESTRICTIONS

- Capabilities of both vendors available to all agencies.
- Highly responsive local office automation support.
- Sophisticated database support for EOEA, contractors

Recommended Distributed Network
(continued)

II. BUDGETARY INCREMENTS (Base + Modest)

Steps	Description	One-time	Annual
BAS:1	**Stabilize procedures/staff**	**232,000**	**51,000**
	- 3 Staff	n/a	90,000
BAS:2	**Replace IBM 3031 with 4361-G5**	**232,000**	**(39,000)**
TOTAL OF BASELINE IMPROVEMENTS		**232,000**	**51,000**
MOD:1	**Acquire EOEA and DEQE HW**	**592,000**	**154,000**
	- DEC 8300 for EOEA	300,000	30,000
	- DEC 8200 for DEQE	292,000	34,000
	- 3 staff	n/a	90,000
MOD:2	**Install and use DBMS**	**270,000**	**70,000**
	- on EOEA VAX (assume ORACLE)	90,000	10,000
	- 1 staff @ EOEA, 1 @ DEQE	n/a	60,000
	- contractor: DEQE File	180,000	n/a
MOD:3	**OA/LAN modest**	**150,000**	**45,000**
	- 1 Staff at EOEA	n/a	30,000
	- 40 users @ DEQE, 30 @ MDC	150,000	15,000
MOD:4	**Modest GIS plans**	**200,000**	**n/a**
MOD:5	**Accelerate PC growth, support**		**160,000**
	- 2 Staff at EOEA	n/a	60,000
	- 20 PCs/yr above present rate	n/a	100,000
TOTAL OF MODEST EXPANSION COSTS		**1,212,000**	**429,000**
TOTAL INCLUDING BASELINE AND MODEST		**1,444,000**	**480,000**

Recommended Distributed Network
(continued)

II. BUDGETARY INCREMENTS (Bas + Mod + Aggressive)

Steps	Description ----------	One-time	Annual
INCREMENT TO BASE AND MODEST LEVEL		**1,444,000**	**480,000**
AGG:1	**Larger Central Hardware**	**$909,000**	**$81,000**
	- DEC VAX 8500 (80 users)	909,000	81,000
AGG:2	**DBMS analysis/end-user support**	**300,000**	**90,000**
	- 3 staff	n/a	90,000
	- contractor: Question 4 work	300,000	n/a
AGG:3	**Aggressive OA/LAN expansion**	**330,000**	**52,000**
	- add 30 DecNet links to DEQE	270,000	32,000
	- MicroVAX II for 100 Cambridge	60,000	20,000
AGG:4	**GIS expansion, applications**	**100,000**	**30,000**
	- contractor work	100,000	n/a
	- 1 EOEA employee	n/a	30,000
AGG:5	**Strategic MIS planning**	**80,000**	**n/a**
AGGRESSIVE SUPPORT TO MEET NEEDS		**$1,719,000**	**$253,000**
TOTAL NEW RESOURCES (Mod + Aggr)		**$3,163,000**	**733,000**
INTERNAL CONTRIBUTION FROM EOEA/DEPTS		$600,000	
NET NEW RESOURCES REQUESTED		$2,563,000	$733,000

Recommended Distributed Network
(continued)

IV. PROS AND CONS

PROS

(+) DEC environment is considered more likely than IBM to support ultimate GIS, although either (or neither) may be the ultimate winner; this alternative provides EOEA Data Center with DEC familiarity.

(+) RDMS facility on central VAX is accessible to all agencies.

(+) All agencies get local, highly responsive support for Secretariat-wide, compatible E-Mail, OA; easy growth to more powerful departmental computing.

(+) Outside contractors support speed-up if internal expansion can't meet time-table.

(+) "Classic" DDP approach; specialized data centers save money.

CONS

(-) New technology to Data Center, DEQE

(-) Need T1 or other high-speed links between Somerset, Winter, and Cambridge Street facilities

Exhibit 1.4
Applications by Agency

AGENCY	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
(all)	**CAPICS** - capital projects	**Geographic Info Systems** - expanded applications
	Controller's Purchasing System	**Office Automation** - word processing, electronic mail, BCS/external gateways
	Geographic Info System - mapping and analysis	**Open Space, Farmland and Land Use Database**
	IBM 3270 Pass-through - gateway to BCS	**Publishing** - newsletters, annual reports, etc.
	Mailing Lists - various departments	**RDBMS Applications** - end-user analysis
	MMARS - management accounting and reporting	
	PMIS - personnel	
DEQE	**Air Quality Monitoring, Modeling**	**Facilities Master File** - reference database
	CASS - Computer Analysis of Sewer Systems	**DEQE Regional Data Communications**
	Hazardous Waste Manifest Tracking	**QUESTION 4 CLEAN UP SUPPORT** - various applications
	Inspections and Maintenance - Air Quality permitting	**Field Investigative Team Support** - Div Solid and Hazardous Waste
	PALIS Lakes Water Quality Modeling	**Permit Compliance System** - Federal water program enforcement

Exhibit 1.4
Applications by Agency
(continued)

AGENCY	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
DEQE (cont'd)	**Right To Know** -workplace materials disclosure	
	Stationary Source Enforcement and Inventory System - Air Quality enforcement	
	Water Pollution Control Timesharing - Tech Services analysis for Westboro	
	Water Pollution Modeling - Federal EPA	
	Water Supply Cross Connections - billing	
	Water Supply and Acquifer Modeling	
DEM	**Computer-Aided Design** - Planning and Development Division	**Dam Safety Inventory** - Waterways Division
	Forest Tax Law - Chapter 61 land inventory	**DEM Dimensions** newsletter
	Recreation Facilities Inventory	
	SCORP - Forest and Parks Division recreation facilities inventory	**SCORP Enhancements**

Exhibit 1.4
Applications by Agency
(continued)

AGENCY	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
MDC	**Accounts Receivable**	**Computer-Aided Design and Drafting;** Automated Mapping and Facilities Management - spatial information systems
	Blue Hills Forest Inventory - plant species	
	CJIS - Criminal History Safety Board system access	
	Mobile Data Terminal - on-line remote query for MDC police	
	Police Accidents and Citations - statistical analysis	
	Police MIS - dispatching and analysis	
	Public Affairs and Public Information - office automation and desktop publishing	
	Summer Youth Payroll	
DFA	**Constituency Lists** - farms, beekeepers, nurseriës, etc.	**Cattle Brucelosis** - test results
	County Fair Prizes - income tax reporting	**WIT coupon redemption** - analysis

Exhibit 1.4
Applications by Agency
(continued)

AGENCY	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
DFA (cont'd)	**Dairy Licensing**	
	Pesticides Licensing and Certification	
	Mosquito Controll Payroll	**Pesticide Registration Program**
DFWELE	**All-Terrain Vehicle Licensing**	**Boating Violation Reporting** - online from radio room
	Commercial Fisheries Licensing	**Law Enforcement Management Information System**
	Lobster and Shellfish Statistical Reporting	**Saltwater Sport Fishing Licensing** - if legislation passes
	Lobster Population Dynamics Modeling - Woods Hole	
	Motor Boat Registration	

Exhibit 1.5
Diagram of Proposed Network

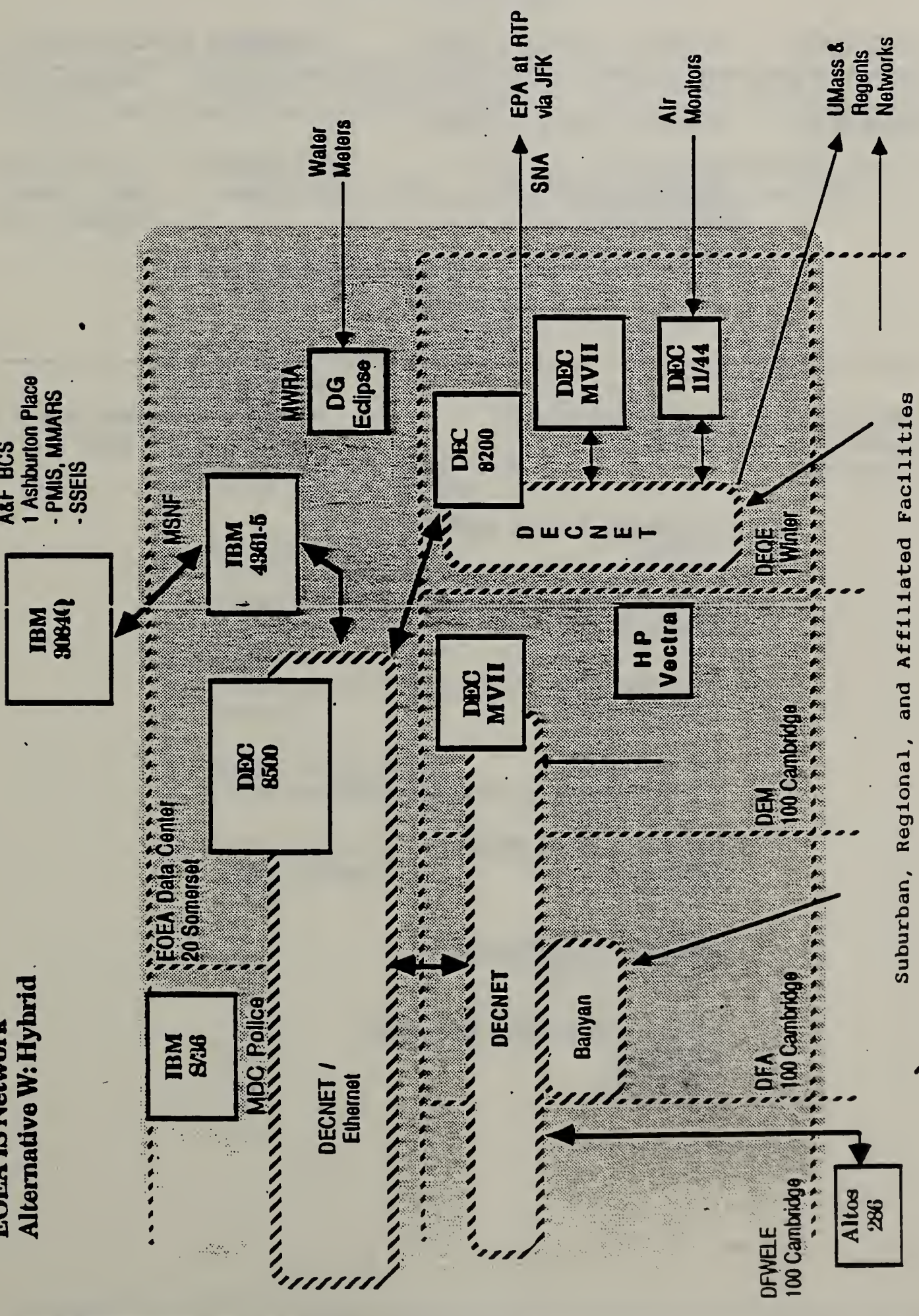

Exhibit 1.6
Applications by Computer Location

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
OMIS BCS	**CAPICS** - capital projects **MMARS** - management accounting and reporting **PMIS** - personnel **SSEIS** - Air Quality Enforcement	
EOEA Data Center - IBM 4361	**Accounts Receivable** - MDC **All Terrain Vehicle Licensing** - DFWELE **Commercial Fisheries Licensing** - DFWELE **Dairy Licensing** - DFA **Forest Tax Law** - DEM Chapter 61 land inventory **Hazardous Waste Manifest Tracking** - DEQE **IBM 3270 Pass-Through** - gateway to BCS **Lobster and Shellfish Statistical Reporting** - DFWELE	(no new applications, most to be converted to new DEC environment)

Exhibit 1.6
Applications by Computer Location
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
EOEA Data Center - IBM 4361 (cont'd)	**Mailing Lists** - various departments	(no new applications, most to be converted to new DEC environment)
	Motor Boat Registration - DFWELE	
	Pesticides Licensing and Certification - DFA	
	Police Accidents and Citations - MDC statistical analysis	
	Right-to-Know - DEQE workplace materials disclosure	
	SCORP - DEM recreational facilities inventory	
	Summer Youth Payroll - MDC and DEM	
	Water Supply Cross Connections - DEQE billing	

Exhibit 1.6
Applications by Computer Location
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
EOEA Data Center - DEC VAX 8500	(none, does not exist)	**All Terrain Vehicle Licensing** - DFWELE - converted from IBM **Commercial Fisheries Licensing** - DFWELE - converted from IBM **Dairy Licensing** - DFWELE - converted from IBM **Facilities Master File** - DEQE reference database **Forest Tax Law** - DEM Chapter 61 land inventory converted from IBM **Hazardous Waste Manifest Tracking** - DEQE - converted from IBM **Inspections and Maintenance** - DEQE Air Quality permitting - converted from U Mass **Lobster and Shellfish Statistical Reporting** - DFWELE - converted from IBM **Motor Boat Registration** - DFWELE - converted from IBM **Open Space, Farmland, and Land Use database** - multi-agency

Exhibit 1.6
Applications by Computer Location
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
EOEA Data Center DEC VAX 8500 - cont'd	(none, does not exist)	**Permit Compliance System** - DEQE, modeled after federal water enforcement
		Police Accidents and Citations - MDC statistical analysis - converted from IBM
		Question 4 Cleanup Support - DEQE
		Right-to-Know - DEQE workplace materials disclosure - converted from IBM
		Saltwater Sport Fishing Licensing - DFWELE if pending legislation passes
		SSEIS - DEQE converted from BCS IBM
		Tech Services Analysis - DEQE Westboro - converted from U Mass
		Water Supply Cross Connections - DEQE converted from IBM

Exhibit 1.6
Applications by Computer Locati
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
DEQE DEC VAX 8200	(none, does not exist)	**BCS, External Gateways** **Office Automation**
MDC Police IBM Sys/36	**Police MIS** - dispatching and analysis	(no new applications)
Agency PC networks	**Blue Hills Forest** - MDC plant inventory	**Cattle Brucelosis** - DFA test results
	Computer-Aided Design - DEM	**Computer-Aided Design** - MDC
	Constituency Lists - farms, beekeepers, etc. - DFA	**Electronic Mail**
	County Fair Prizes - DFA income tax reporting	**Field Investigative Team Support** - DEQE
	Public Affairs and Public Information - MDC	**Publishing** - newsletter, annual report
		Office automation
U Mass-Amherst CYBER	**PALIS Lakes Water Quality Modeling**	
	Water Pollution Control Timesharing	

Exhibit 1.6
Applications by Computer Location
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
Regents Computer Network - CDC Cyber	**Inspections and Maintenance - DEQE Air Quality permitting**	
	Water Pollution Control Timesharing	
DEQE PDP-11	**CASS - Computer Analysis of Sewer Systems**	
DEQE PDP-11 (cont'd)	**Water Supply and Acquifer Modeling**	
DEQE MicroVAX II	**Air Quality Monitoring and Modeling**	
Woods Hole Ocean-ographic Institute - DEC VAX	**Lobster Population Dynamics Modeling - DFWELE**	
US Geologic Survey - - Prime 9955	**Geographic Information System - mapping, analysis**	
Criminal History Systems Board	**CJIS - Criminal Justice Information System access - MDC Police**	

Exhibit 1.6
Applications by Computer Location
(continued)

LOCATION	PRESENT APPLICATIONS	PROPOSED APPLICATIONS
Federal EPA IBM main-frames	**Water Pollution Modeling** - DEQE	
	AIRS - air quality modeling	
	Permit Compliance System - DEQE, for Federal water program enforcement	
	Other modeling and database applications	
Other or not yet determined		**Boating Violations Reporting** - DFWELE online from Radio Room
		WIT Coupon Redemption - DFA

Exhibit 1.7
Summary of EOEA ADP Initiatives
Fiscal Years 1985-1986

AGENCY	INITIATIVE	EOEA DATA CENTER USE
DEQE	Establish Department communication network	yes
	Implement, enhance Department OA	yes
	Stategic Source Enforcement and Inventory System	yes + BCS
	Linkage to State and Federal	yes + EPA
	Computer Systems and Services	UMASS + RCN
	Data Management for F.I.T.	no (micros)
	Right-to-Know	yes
	PMIS	yes + BCS
	Enhance Hardware, Software Systems	yes
	EDP Personnel	no
	Envronmental Data Scoping Study	yes
DFWELE	Ecological Resource Management	no (micros)
	Div. Admin. Automation	no (micros)
	OA, WP	no (micros)
	Cat Cove Marine Lab	yes
	Integrated Remote Job Entry	+ micro
	Shellfish Plant Tracking	no (micros)
	Suspended Registration Tracking	yes
	On-line A.T.V. Sys.	yes
	On-line Boat Hull Id #	yes
	Boat Class Reporting System	yes
	Law Enforcement Radio Room Communications	yes
	On-line Environmental Violation Reporting System	yes
	Com. Fishing Stat. Rep. Package	yes
	Marine Fish License System	yes
	Sandwich Remote Scientific DP Station	yes + WHOI
	Sandwich word/data processing	no (micros)

Exhibit 1.7
Summary of EOEA ADP Initiatives
Fiscal Years 1985-1986
(continued)

AGENCY	INITIATIVE	EOEA DATA CENTER USE
DEM	Comp. of Fiscal Dept.	yes
	Operations Improvement - C.A.D.	no (micros)
	River Basins Plan	micros + USGS
	GIS	micros + USGS
	Capital Projects, contracts,	yes
	Dams and Great Ponds Inventory	micros
	Auto. of Reg. Forests & Parks Off.	
	Departmental WP	micros
MDC	MDC Police communications and database	yes + mini
	Community Affairs WP	micros
	Access Comptroller System	yes + BCS
	CAD Initiative	yes + mini
DFA	Animal Health OA	no (micros)
	Pesticides Registration	yes
	Mosquito Control	no
EOEA	EOEA database and WP	no
	MEPA database and WP	no
	CZM database and WP	no
	Data Center IBM 3031	yes
	Right-To-Know	yes
	Summer Youth Payroll	yes
	Expand telecommunications access	yes
	Expand Data Center staff	yes
	Foster user self-sufficiency	yes
	Encourage appropriate use micros	no
	Upgrade data entry equipment	yes
	User Needs & Capacity Study	yes
	User Chargeback Policy	yes
	Disaster Recovery Plan	yes

Exhibit 1.8
Environmental Responsibilities and Information Needs

Environmental Programs	Information Technologies OA	DBMS	GIS	TP
Hazardous Waste				
- Site Assessment	*	*	*	
- Containment/cleanup	*		*	
- Project Management	*			
Open Space				
- Land Acquisition	*		*	
- Preservation	*		*	
- Planning/management	*	*	*	
Waste Management				
- Facility Siting	*		*	
- Manifest Tracking	*	*		*
- Recycling and Reuse	*	*		*
- Source Reduction	*	*		*
Costal/Marine Resource Management				
- Boston Harbor Cleanup	*	*	*	
- Fisheries Mgmt and Habitat Protection	*	*	*	*
- Coastal Water Quality Monitoring	*	*	*	
- Public Access	*		*	
Drinking Water Quality Management				
- Aquifer Protection	*	*	*	
- Water Management Act	*	*	*	
- Public Water Supply Testing/Federal Clean Water Act	*	*	*	
Environmental Risk Management and Enforcement				
- Right-to-Know	*	*		*
- Air Quality Control	*	*		
- Pesticide Regulation	*	*	*	*
- Acid Rain		*	*	
- Administrative Penalties	*		*	*
- Permitting	*		*	*

Exhibit 1.9
Costs by Resource Type

($ in 000)

CATEGORY	YEAR1	YEAR2	1-TIME	TOTAL	REMARKS
Hardware	$162	$162	$1,286	$1,610	4361, VAX 8500, VAX 8200
Software	34	34	210	278	for VAX
Staff	455	455		910	12 EOEA, 1 DEM 3 DEQE, 1 MDC
Contractor			860	$380	EOEA
				$480	DEQE
TOTALS	$651	$651	$2,356	$3,658	

Chapter 2: The Planning Process

The EOEA Information Technology Plan was produced by EOEA and agency staff and consultants working together over a period of 6 months. This chapter presents our methodology and approach.

2.1 PROJECT PROCESS AND PARTICIPANTS

The project was started in mid-November, 1986, by Rick Taupier, EOEA Assistant Secretary for Research and Data; Mr. Taupier served throughout as Project Manager. Drs. Jerry Mechling, Principal, and Bill Byrn, Associate, of Hayes-Mechling-Kleiman, Inc., worked on the project as consultants to the planning team.

The approach has been participative. Agency staff and management were crucial to building shared understanding of the technical, organizational, and economic issues, and to developing commitment to the final results.

Exhibits 2.1 and 2.2 identify members of the Data Policy Committee and the Information Technology Task Force, the working groups that developed this plan. The Data Policy Committee (Exhibit 2.1) is a pre-existing coordinating group with representation from all EOEA agencies.

From December to March, this group met 6 times for about 3 hours per meeting. Early sessions were devoted to sharing information about agency programs, computer applications, and 'unmet' information needs. Later sessions focused on developing alternatives and evaluation criteria and finally on selecting a recommended plan.

Exhibit 2.2 identifies the senior managers at EOEA who, together with members of the Data Policy Group, formed the Information Technology Task Force. The

Exhibit 2.1
EOEA Data Policy Planning Group Members

Rick Taupier	Assistant Secretary for Data and Research, EOEA (Chair)
Charles Anderson	Senior Marine Biologist, DFWELE
Kevin Ascolillo	DP Co-ordinator, DFA
Michael J. Byrne	Executive Assistant for Operations, MDC
Jacquie Doherty	DP Co-ordinator, DEQE
Kenneth Hagg	Acting Deputy Commissioner, Planning and Management, DEQE
Ed Kane	DEQE
Russell Isaac	Technical Services Branch, DEQE
Lt. Dermot Quinn	MDC Police
Gerald Roosa	Deputy Commissioner, DEM
John Shontell	EOEA Data Center Manager

Task Force convened twice during the project. The first meeting, an all-day workshop on

December 2, 1986, provided a framework for understanding the planning problem. The workshop addressed technical trends and concepts, the potential of information technology in government and service organizations, and the limitations, risks, and issues involved in technology management (e.g. decentralization).

The second workshop, on March 2, 1987, reviewed and then endorsed the analysis and recommendations of the Data Policy Committee.

Exhibit 2.3 identifies additional people who were interviewed or otherwise supported the study.

Exhibit 2.2
EOEA Information Technology Planning Group

Hon. James S. Hoyte	Secretary, EOEA (Chair)
Walter Bickford	Commissioner, DFWELE
William J. Geary	Commissioner, MDC
James Gutensohn	Commissioner, DEM
Deborah V. Howard	Senior Assistant Secretary, EOEA
S. Russell Sylva	Commissioner, DEQE
August Schumacher, Jr.	Commissioner, DFA

(plus members of the Data Policy Group)

Exhibit 2.3
Other Participants and Interviewees

John Dacey	MIS Consultant
Lorraine Duffy	Systems and Programming Manager, EOEA Data Center
Chris Kennedy	Assistant. to Commissioner, DFWELE
James L. McAbee	MDC
Joe Noga	BSPP, OMIS
Jerry Patz	BSPP, OMIS
Chris Phillips	Public Relations, DFA
Walter Phoenix	Phoenix Associates (consultants to MDC)
Joe Santos	Customer Service, EOEA Data Center
Mary Shaughnessy	Budget, Administration and Finance
Miriam Schwaller	Librarian, OMIS
Joel Searcy	Phoenix Associates
Janice Tatarka	Budget office, Administration and Finance
Michael Terner	HWFSSC
Patricia Wada	BSPP, OMIS

2.2 APPROACHES TO CAPACITY PLANNING

There are two broad approaches often recommended for determining an organization's computer requirements:

1. The **'top down' approach** is often appropriate where the systems function is immature or undergoing a major change. Starting from top-level priorities, this approach develops a mission-by-mission identification of needed applications. An allowance for growth can be factored in to produce workload projections.

2. Alternatively, the **'bottom-up' approach** is appropriate where the systems function is mature, or where users have a substantial investment in existing applications. In this approach, future workloads can be 'built up' by a detailed assessment of growth, needs for replacement, and proposed new systems. Current workload plus known trends can then be used to justify new systems.

For this study we found that today's workload at the EOEA Data Center does not provide a sound basis for extrapolation. This was because of the reliance on outside suppliers, and because proposed applications were different in character from existing applications (e.g., while the EOEA Data Center supports CICS, COBOL, and VSAM, the proposed applications require end-user computing, analytics, and office communications). While the bottom-up approach was therefore of limited value, we did not have the resources required for a detailed top-down plan.

In response, we selected a hybrid methodology. First, we examined applications presently supported by the Data Center, evaluating them as to scale, likely growth or evolution, and importance. In addition, we estimated the scale and character of suggested applications, some of which are only in the 'concept' stage, and some of which depend on pending legislation. This process was as thorough as we could make it, but undoubtedly not exhaustive: numerous proposals remain to be discovered.

The configurations in our 'finalist' alternatives -- presented in Chapter 3 -- reflect workload from existing applications along with new applications. We recommend that the central processing system handle at least 3 MIPS, or three times the present system's raw processing speed. Most of this increase is for new applications rather than growth in existing applications. Exhibit 2.4 summarizes the elements we considered in the sizing decision.

The recommended system also reflects a change in role for the EOEA Data Center, equipping it to support-end user computing, scientific and analytic work, local and wide area networks, and relational database tools. None of these are now major activities of the Data Center.

Exhibit 2.4
EOEA Growth in Computer Usage

SOURCE	1987	Prime shift simultaneous users, by date @conversion	+1 yr	+4 yr
IBM 3031	20	12	14	16
NEW SYSTEM	0			
From conversion*				
Right to Know		1	4	9
Hazardous Waste Manifest				
SSEIS, motorboats, etc.				
Other than R-T-K		11	15	21
Identified RDBMS		5	12	25
Facilities Master File				
Question 4 systems				
Unidentified RDBMS*			2	8
Spare capacity for response-time				18
Total Estimated Prime-Shift Simultaneous Users				97

This represents a more than four-fold increase in prime shift simultaneous users within a two to four year period. Note this growth has NOT allowed for bringing GIS work in-house. The GIS work alone is estimated to be equivalent to approximately 70 simultaneous users in terms of its processing power requirements. In general, as users "get into" the kind of data analysis encouraged by RDBMS systems and required for effective environmental management and enforcement, we expect to see these kinds of growth. To handle it, we estimate a need for a three-fold increase in processing power (million of instructions per second increasing from approximately 1.1 to above 3.0), and a 40% per year growth in on-line storage (to a total of approximately 4 to 6 gigabytes). The user community (a number larger than prime time simultaneous users) can be expected to increase from approximately 150 now to 260 with the new machines to 400 shortly thereafter.

* Experience shows a large growth in usage when database management tools become available for analysis of well-known databases. Within as short a period as 1-2 years, some organisations have found that more than half their computing load shifts to this new form of computer support.

There are always risks in such predictions of the future. If EOEA acquires too much computing capacity, there is an economic cost of excess capacity (although this capacity will soon be utilized by growing demand). If EOEA acquires too little computing capacity, the problem will not be economic so much as managerial: it will be extremely difficult to obtain, share, and analyze the information required to meet its environmental responsibilities.

Chapter 3: EOEA Information Technology Status

This chapter evaluates the use of information technology (I-T) by agencies of the EOEA as of spring 1987. We describe applications, hardware, software, and staff. This material has been assembled through interviews and approved AF29 files.

3.1 THE EOEA SECRETARIAT

There are two I-T roles performed at the EOEA Secretariat level. First, the Secretariat provides guidance through the Assistant Secretary for Research and Data. Secondly, by operating the EOEA Data Center, the Secretariat provides direct resources for agencies and other users. The Secretariat has no applications to directly support its own operations.

The Assistant Secretary for Research and Data guides I-T by reviewing proposals and budgets. He does not have control over I-T budgets. He is supported by a Data Policy Committee of "DP Coordinators" from each Agency. The Data Policy Committee normally meets monthly to co-ordinate information and activities; it has no formal charter or powers.

The EOEA Data Center, located on the 3rd floor of 20 Somerset street, operates an IBM 3031 mainframe and provides computing resources for all EOEA agencies. Access is from IBM (or equivalent) terminals via leased lines. Appendix C lists the hardware and software of the EOEA Data Center along with annual maintenance costs. Not included are costs for auxiliary devices (such as card punches), or for space, electricity, consumable supplies, or air conditioning.

Through special software (IBM's MSNF) and a link to both of the Bureau for Computer Services IBM systems, users of the Data Center may reach BCS

applications, including the state-wide MMARS system for financial accounting, the PMIS system for human resources accounting, and CAPICS, the Capital Projects Information and Control System. Minor use is made of the BCS DP Equipment Inventory and the Controllers/Purchasing System.

The 15 staff of the EOEA Data Center include:

1 Data Center manager
1 Customer Support manager
1 Receptionist
1 Operations manager
1 Data entry manager
2 Data entry staff
2 Chief computer operators (day, eve)
1 Computer operator
1 Systems and programming manager
1 Software team leader
2 Senior systems analysts
1 EDP programmer III

Two other positions, already authorized, may soon be filled.

The responsibilities of this staff are to develop, build, operate and maintain applications for the IBM mainframe. The primary applications involve transaction processing (structured record-keeping) using IBM software such as CICS/DL1 and DMS.

In addition, the Data Center plans and manages EOEA-wide data communications. The Data Center does little to support personal computer users, although two staff do what they can on an informal basis.

Secretariat-level staff use the BCS MMARS and PMIS systems. In addition, the Coastal Zone Management office maintains a computerized mailing list at the EOEA Data Center. Through an arrangement with the US Geological Service (USGS) and contractors, the Hazardous Waste Site Safety Council in the Secretariat's office has developed early projects with mapping and site analysis; these are part of a plan to develop a major investment in Geographical Information Systems.

All other processing at the Data Center supports one or more of the EOEA agencies, not the Secretariat itself.

3.2 AGENCY STATUS

Outside the EOEA Secretariat, we reviewed applications and facilities supporting the five EOEA agencies.

3.2.1 Department of Food and Agriculture.

The Department of Food and Agriculture (DFA) has two major applications at the Data Center, and about a dozen IBM PC applications at department headquarters. Approximately six of the Boston PCs are linked in a Banyan local area network. Field offices in Lancaster and Springfield access this network through IBM PCs via dial-up. The department has two staff to support its computer work, one "planner" and one "PC support/developer."

The DFA also uses CPT stand-alone word processors, memory typewriters, and ITT CRTs for Data Center access.

The DFA applications at the EOEA Data Center are:

PESTICIDES LICENSING AND CERTIFICATION. This application, written in CICS/DL1 and COBOL, records tests given to the employees of pesticide companies and to each farmer who uses pesticides. An annual renewal is required for licensing. Approximately 6000 individuals are on file.

DAIRY LICENSING. This application tracks the annual inspections of dairies selling in Massachusetts and surrounding areas, as required by Massachusetts law.

Applications on the PC network were implemented through in-house database design in the SMART PC database. Most support communication with program constituents. They include:

FARM INVENTORY. A name and address file of the 11,000+ farms with $1000+ in annual revenue. This inventory in successfully seeking higher U.S.D.A. Extension Service budgets.

FARMLAND PRESERVATION. An inventory of farmlands already purchased (approximately 200 records) or in process (approximately 150 records).

BEEKEEPER INVENTORY.

DAIRY INVENTORY.

FARMER'S MARKETS/ROADSIDE STAND INVENTORY.

FLOWER MARKET INVENTORY.

FOOD PROCESSOR BUSINESSES (approximately 1300 records).

COUNTY FAIR PRIZE TAX TRACKING. Generates federal 1099s for prize monies (over $600 to one individual) awarded at County Fairs; ensures that winners report income.

MILK PROCESSORS/FEES. Supports a highly confidential analysis of milk processors.

3.2.2 Department of Environmental Management.

DEM has five divisions with distinct charters and programs. DEM headquarters has a mailing list for its publications at the EOEA Data Center, and a multi-terminal Wang word processing system in-house.

The Forest and Parks division is the primary user of two Data Center databases:

SCORP (Statewide Comprehensive Outdoor Recreation Plan). This is an inventory of public and private recreational facilities, updated (and partially redesigned) every five years, and used in part to justify federal funds. It is implemented in COBOL and DMS, with about 8,000 records.

CHAPTER 61 (Forest Tax Law Management). This program helps owners of woodlands become eligible for reduced taxes by filing management plans for their property with the state.

The Planning and Development Division, responsible for construction, has recently acquired a Computer Aided Design system for physical planning; it runs on a Hewlett Packard VECTRA personal computer and AutoCad software.

The three other DEM divisions are Solid Waste Disposal (administration of the "bottle law"), Waterways (flood control, state piers, dam safety), and Water Resources (drinking water safety, well registration, long range water planning). Their only computerization is word processing and PCs.

3.2.3 Department of Environmental Quality Engineering.

DEQE is a major user of computing for research and analysis, for licensing and permitting programs, and for office communications.

DEQE's computing is provided by the EOEA Data Center, the BCS Data Center, by two in-house DEC minicomputers, and by external suppliers such as the Federal EPA, UMass, and the Regents Computer Network. DEQE also uses more than 80 personal computers.

Four heavily-used DEQE applications reside at the EOEA Data Center:

RIGHT-TO-KNOW. This growing database supports record-keeping and disclosures mandated by the Massachusetts Right-to-Know law. An inventory is maintained by employer and by facility for hazardous chemical used in the work place. This information must be maintained for access, under carefully controlled rules, by unions, employees, and the public.

Written in COBOL and DMS, the application maintains a Master Substance List (revised annually) and Material Safety Data Sheets. Query is through the IMAGINE software product, typically on an overnight batch basis due to memory limitations at the EOEA 3031 machine. Compliance is low at this point -- perhaps 10% -- but there will ultimately be 600,000 worksheets when full compliance is achieved.

Appropriately authorized staff in DEQE's regional offices can use this database. Department of Public Health and Department of Labor and Industry staff also occasionally use the data (through BCS links).

WATER SUPPLY CROSS CONNECTIONS. This is a batch application for inspections by the DEQE Water Supply division and annual billings to cities and towns.

WATER SUPPLY/AQUIFER MODELING. The EOEA Data Center supports 'ad hoc' modeling by DEQE staff using Federal data on magnetic tapes. Programming is in Fortran by DEQE engineers.

HAZARDOUS WASTE MANIFEST TRACKING. This batch application tracks the shipment of hazardous wastes originating in Massachusetts. Over 100,000 records are created each year. The system is used by the Solid and Hazardous Waste Division. It was written by the EOEA Data Center staff in 1984, using COBOL and CICS/DMS.

For the Division of Air Quality, the BCS operates SSEIS, the Stationary Source Enforcement and Inventory System. This is an inventory of air quality permits; it supports the collection of fees and other enforcement, and uses the same facility coding scheme used by the Right-to-Know and the Hazardous Waste Manifest Tracking System.

SSEIS was developed for Massachusetts by the Federal EPA. It uses ADABAS for data management and COM-PLETE for transaction and datacomm facilities. SSEIS outputs are used to meet EPA reporting requirements.

The Division of Air Quality also uses a DEC MicroVAX II for on-line air quality instrumentation. Prior to 1987, a PDP11/44 was used for this application.

The DAQ also operates the Inspections and Maintenance Database. Located on the Regents Computer Network, this is implemented in SPSS.

The Water Pollution Control Division (Technical Services Branch, Westboro) uses external computers for modeling and analysis:

> PALIS. This provides lake water quality modeling at the University of Massachusetts - Amherst. It runs on VAX and CDC Cyber computers and uses the "S.I.R." data management system. The application provides remote access to modeling software at EPA's IBM mainframe at Research Triangle Park, North Carolina (datacomm through the JFK Building in Government Center, Boston).
>
> CASS (Computer Analysis of Sewer Systems). This was built and previously operated by a contractor. It is being brought in-house on a Digital PDP11/44 (previously used by the DEQE Air Quality Division).

The total annual cost of outside computing for Water Pollution Control and DAQL is estimated at over $80,000. The DEQE Division of Solid and Hazardous Waste contracts with Chemical Information Systems, Baltimore, at an annual cost of approximately $30,000.

In addition to the above 'formal' applications, DEQE uses more than 80 personal computers for word processing, analysis and small databases. PCs in the four Regional offices (Springfield, Lakeville, Woburn, and Worcester) have access to Right-to-Know and SSEIS.

During 1986-87, DEQE developed a rather comprehensive set of applications and data management plans. These were supported by an inventory of internal 'databases' developed by American Management Systems.

3.2.4 Department of Fisheries, Wildlife and Environmental Law Enforcement.

The DFWELE uses IBM PCs at Headquarters and at offices in East Sandwich, Newburyport, and Westboro, with CPT stand-alone word processors and ITT CRT terminals at Headquarters. The department has one planner and one programmer/systems developer.

The Environmental Law Enforcement division maintains two major inventories at the EOEA Data Center:

> MOTOR BOAT REGISTRATION. This contains 150,000 motor boats with state registrations and produces an annual listing used by cities and towns for excise tax assessments. It also produces tapes with information about stolen boats which are sent to the Public Safety department (Criminal History Safety Board). Previously run at an external service bureau, the Motor Boat Registration System was rewritten in the 1980s in COBOL and DMS. It does not yet support some desired access keys (e.g., Boat ID).
>
> This application's voluminous data entry requirements are currently centralized; decentralizing data entry would require a partial redesign.
>
> ALL-TERRAIN-VEHICLE LICENSING. Approximately 60,000 ATVs are regulated by the Enforcement Division. This on-line application records each license and annual renewals.

The Marine Fisheries Division also uses the Data Center. There are three primary applications:

> FISHERY INVENTORY. This consists of three inter-related, on-line files: Dealers, Duplicate Issues, and Special Permits.
>
> LOBSTER/SHELLFISH STATISTICS. This enters data using COBOL/DMS and subsequently analyzes it using SPSS-X, a statistical tabulating package. The system was designed by a contractor (Touche Ross) but programmed in-house.
>
> MAILING LIST.

The Marine Fisheries office in Salem uses a small minicomputer (Altos 286 with 3 PC workstations) for off-line data entry to the EOEA Data Center and access to BCS.

The Westboro office of Fisheries & Wildlife has direct access to University of Massachusetts Computation Center facilities for small applications involving SPSS and BMDP (another statistical package).

In addition, the Division of Marine Fisheries uses the VAX minicomputer at the Woods Hole Oceanographic Institute for modeling the dynamics of the lobster population. DMF has also archived approximately 250,000 records (20,000 per year) in a Fisheries Assessment program.

Staff at the DFWELE have been involved in planning and development of the proposed Geographic Information System and computer-aided mapping; these tools could support land acquisition, public use planning, and other agency programs.

3.2.5 Metropolitan District Commission.

The MDC is host to the EOEA Data Center but is not a major user. There are only three Data Center applications active for the MDC:

ACCOUNTS RECEIVABLE. Batch system, implemented in RPG II.

POLICE ACCIDENTS AND CITATIONS. An on-line system which collects data about each accident and citation. The data is used to analyze changes in enforcement levels, staffing, signage, etc. Data is entered with DMS and COBOL, with queries in IMAGINE.

SUMMER YOUTH PAYROLL. This is a special payroll for the MDC's large summer youth work force, since PMIS does not support the weekly processing and calculations needed. This software also supports the staff of the Mosquito Control Board, part of Department of Food and Agriculture.

The MDC Police operate a turnkey Police Management Information System (PMIS) developed by CES Telecommunications in Chicago. Based on an IBM System/36 minicomputer, the system aids in dispatching MDC police to calls for service, then records the results. The MDC uses the system primarily for off-

line, after-the-fact record-keeping. It can be accessed from most of the MDC's district offices via terminals or IBM PCs.

The Sys/36 minicomputer is connected to the EOEA Data Center's IBM 3031 (and thereby to BCS); users at remote MDC terminals can get access to IBM mainframes at EOEA and BCS.

The staff of the MDC uses about 5 personal computers for record-keeping and small-scale word processing. These are found in Public Information (an Apple MacIntosh for press materials), Finance (daily statements for bond funding), Public Affairs (mailing lists), Parks and Engineering (for financial analysis of construction projects), and the Blue Hills Reservation (mostly for an inventory of plants).

During FY87, the MDC conducted an extensive examination of data needs and opportunities for office automation; this work was led by a management consultant, Phoenix Associates.

3.3 ASSESSMENT OF EOEA PROGRESS AND STATUS

In planning for information technology, it is useful to assess the past and consider how the future may differ. The "Stage" theory of growth, first presented in the 1970s by Drs. Cyrus Gibson and Richard Nolan, then of the Harvard Business School, provides a widely used methodology.

3.3.1 Stages of Growth

The use of information technology has often been observed to progress through four stages. These reflect organizational learning in adapting to the technology:

> **Stage 1: Initiation.** This stage is typically characterized by batch applications, a volume or 'production' orientation to machine operations, centralized technical staff, and the absence of formal planning or budget controls. Transaction-processing financial applications such as payroll and accounts payable are usually the first to be implemented.
>
> **Stage 2: Growth.** This stage involves rapid growth and 'new markets' for information technology within the organization. On-line applications appear, bringing many more people into direct contact with the technology. Management begins to develop more formal project planning and selection processes.

> **Stage 3: Control.** After the rapid growth of the previous stage, this is the era for formal planning and control mechanisms. Management gives greater attention to multi-departmental applications and multi-application databases ("the information resource"); these require database tools and the development of organization-wide data element standards. During Stage 3, management often distributes some of the technical staff to user departments. These people help develop analytic and query-oriented applications for middle managers.
>
> **Stage 4: Maturity.** In this stage, the organization has developed a mature understanding of the potential, risks and value of information technology. Management decentralizes more staff (and equipment), and develops applications with broader, even strategic, impacts.

The "Stages of Growth" can be used both to 'position' an organization and to predict the challenges that lie ahead.

3.3.2 EOEA's Position and Evolution

By most measures, EOEA's use of information technology is at Stage 2, with some aspects at Stage 3 and many at Stage 1.

The primary technology indicators for diagnosing EOEA as a "Stage 2" organization are:

1. **Most EOEA applications are designed around a single main file and a batch posting stream.** While several offer on-line data entry, only a few offer on-line interactive inquiry. (Some applications designed for interactive query are operated only in overnight batch inquiry mode, due to lack of computer power.)

2. **No database management facilities are available.**

3. **Applications are written mostly in second-generation, compiled languages such as COBOL and FORTRAN.** A fourth-generation query facility is available (IMAGINE), but there are no fourth-generation application builders such as FOCUS or RAMIS.

The application-related indicators of EOEA's "Stage 2" status are:

1. **Most applications serve a single user or work group, and support basic transaction-driven operations.**

2. **The process used to select which applications will be developed is relatively informal and ad hoc.**

3. **Management has not developed data element standards to support widespread data sharing** (with the exception of a consistent scheme for facilities labelling in three DEQE applications.)

4. **Although some applications are 'analytic', these are scientific rather than managerial.** They may indirectly support policy-making, but do not analyze management decisions.

5. **Many personal computers are "island" PCs** and are used only in a stand-alone mode; they do not have network support or links to the EOEA or BCS mainframes.

Finally, the organizational indicators of EOEA's "Stage 2" status are:

1. **Information technology staff and facilities are highly centralized.**

2. **Planning and control remain largely informal.**

3. **Management has not yet established a widely accepted and fair accounting system for the use of information resources.**

4. **Departmental users are eager for rapid growth in new applications.**

5. **Planning occurs on an incremental, step-by-step basis through the AF29 process;** Few Secretariat-wide priorities exist which would provide a clear context for tradeoffs.

The above diagnosis is not intended to downplay the accomplishments of a small technical staff with a very restrictive budget and out-of-date facilities. The Data Center and agencies have built or acquired many cost-effective and valuable applications; these will continue to serve the Commonwealth for years to come.

Our analysis does suggest, however, that the EOEA is generally positioned to enter Stage 3. Stage 3 challenges and activities will likely include:

1. Decentralization of staff and facilities
2. On-line applications
3. Formal project selection procedures
4. DBMS and 4th generation development tools
5. The development of data management standards
6. Analytic and executive support applications
7. Accountability for information resources
8. Increased demand for management involvement in setting priorities
9. Networking and office automation

These issues need to be considered in selecting EOEA hardware and software, in deciding where it should be located, and in organizing how it should be governed. They present important and new challenges for EOEA management.

Chapter 4: Alternatives and Anlysis

In developing an EOEA plan, the Data Policy Group considered a range of hardware, software, and organizational options. In this chapter we present our alternatives and analysis. We describe the development of alternatives, the evaluation criteria, and the results.

4.1 DEVELOPMENT OF ALTERNATIVES

From the outset, the Data Policy Group addressed the planning problem in a broad manner. Rather than ask what computer should replace the IBM 3031 at EOEA, for example, the Group first sought to determine the scale, direction and broad priorities for the future. Questions included:

1. **How much should EOEA spend?** At what rate can EOEA spend productively?

2. **Who should spend the money?** (Agencies? Data Center?) Who should control development resources?

3. **Which types of applications should take precedence?** Transaction processing? Analysis? Communications?

4. **How shall resources be balanced?** How much to hardware, staff, software, contractors, PCs, data communications?

5. **What computer characteristics best match the present and future workload?** What are the likely vendor offerings for such workloads?

6. **What will be the implications for users?** Will there be access from current terminals? Disruption from the conversion of existing applications? Reliability in the communication network?

7. **What are the performance implications?** Will capacity and response time be adequate? Can expansion occur smoothly?

The group decided NOT to restrict alternatives to large IBM 370-compatible mainframes with DOS/VSE software. Although an IBM approach would offer easy expansion, it would also have definite limitations:

1. **The future workload will be different.** The environment now (DOS/VSE, CICS, DL/1, COBOL) is focused on transaction processing, but the future will be dominated by analysis, communications, and end-user computing.

2. **DEQE and other agencies need agency-level processing and local networks.** An all-central, all-IBM system would not support these.

3. **The future system should be consistent with plans for the proposed Geographic Information System.** This suggests vendors and product lines which offer:

   - strong scientific (floating point) capability, and;
   - software tools for statistics, modeling, geographic processing.

We noted that some IBM products, but not DOS/VSE or CICS, may support such processing.

Using the above, we developed four 'finalist' alternatives for in-depth evaluation. We based price and performance on specific IBM and Digital Equipment Corporation products.

NOTE THAT IT IS NOT OUR INTENT TO LIMIT THE ELIGIBLE RANGE OF VENDORS TO THESE TWO. The specific products and configurations described below are only to illustrate the general capabilities and capacities required, and to identify approximate costs.

4.2 EVALUATION CRITERIA

Many of our criteria were obvious, but others were more subtle:

1. **Scale and Capacity.** Does the configuration provide the needed power? General targets for the '87-'89 planning horizon were:

-- 3 + MIPS processing speed at the EOEA Data Center

-- 12 Megabytes main storage

-- Support for 6 Gigabytes of disk storage

-- Support of peer to peer networking and IBM pass-through

These targets did not come from extrapolation of past growth. They came, instead, primarily from past experience with growth as end-user computing and relational database work becomes popular. (See Chapter 2, Section 2.)

2. **Alignment with the Future EOEA Workload Mix.** The new systems should support office, analytic, end-user and scientific computing, not just batch and transaction processing. We sought systems which offered:

-- Relational database management systems (RDBMS), including those suitable for end-users as well as for systems developers

-- File and print servers for office LANs

-- Mature PC-to-system links

-- Information center and end-user tools

-- Reasonable floating point performance (and likely compatibility with future GIS needs)

-- FORTRAN IV, COBOL, normal utilities and security features, and bi-synchronous 3270 terminal support

3. **Costs and Predictability.** We developed comparisons involving:

- -- Onetime costs (for purchase,installation)
- -- Ongoing costs (for maintenance, software, the environment)
- -- Size of system support staff
- -- Likely ability to control costs

4. **Risks, Ease of Conversion.** For each alternative, we considered the conversion path from the present system.

5. **Lead Time to Acquire, Install, Utilize.** These are significant in all cases, and likely to be longer for some configurations than others.

6. **Internal and External Support.** Will the alternative command the support it needs among EOEA and departmental staff? Will it be successful in the context of other executive and legislative concerns?

We also discussed other criteria -- reliability, vendor reputation, delivery schedule, accountability for results, etc. Such factors are important, but were not helpful in discriminating among alternatives at this stage. They may well become important later.

4.3 ALTERNATIVES AND ANALYSIS

We examined four major alternatives, with different funding levels within each. The alternatives varied primarily as to the role for departmental vs. Secretariat computing and/or the emphasis given to transactional vs. analytic applications.

4.3.1 Alternative X: Immediately expand the EOEA Data Center and create a similar "full-featured" data center at DEQE.

NOTE: In Alternative X (and all alternatives except Z), a high priority step is prompt replacement of the aging IBM 3031 with a roughly equivalent newer system. Replacement will provide more reliable operations at lower cost. The purpose is NOT more processing power, new software, or to influence the vendor ultimately chosen for the EOEA Data Center. Without replacement, however, Data Center staff will be drawn into fire-fighting and forced conversion of

existing applications; this will divert attention from higher priority newer applications. For budget purposes, the recommended replacement is a machine equivalent to a used IBM 4361-G5, with 8 Megabytes of main memory.

Alternative X initiates departmental computing by acquiring two computers and a network to link them. The larger computer, to be located at the EOEA Data Center, would service all agencies. A smaller computer, to be located at DEQE headquarters, would serve DEQE and be the earliest host for relational database management software.

Alternative X at full funding would include an IBM 4381 Model 11 system using IBM VM/SP for the EOEA Data Center. This would support approximately 80 simultaneous on-line users. The DEQE data center would run a DEC VAX 8500; this would support a LAN in the Winter Street building and approximately 60 on-line users.

Alternative X also includes an intelligent data switch for redirection and protocol conversion for IBM 3270 CRT users seeking access to the DEQE VAX. Similarly, DEQE users at asynchronous CRTs (standard for VAX systems) can access the IBM at EOEA or BCS through VAX-based 3270 pass-through software. Alternative X provides for database management software on both the EOEA and DEQE machines.

The cost for the first two years of Alternative X is $2,695,000. Appendix A presents the budgetary increments associated with this program.

The primary advantages that the Data Policy Group identified for Alternative X include:

1. It is responsive to DEQE's needs for **departmental computing** and for rapid expansion of enforcement required by Question 4. DEQE has a high degree of autonomy and accountability for its own success.

2. Since the DEQE VAX is in the same building as its LAN stations, it can serve as a file server and printer server; this **eliminates the need for a separate file server.**

3. It is consistent with the OMIS vision of **three-tiered computing** (State level, Secretariat-level, Agency level).

4. The skills of two vendors are available (although non-DEQE access to the VAX will depend primarily on DEQE requirements and priorities).

5. The IBM conversion should not be risky or expensive for the EOEA Data Center (from DOS/VSE to IBM VM/SP).

The primary disadvantages that the Data Policy Group found for Alternative X are:

1. While nominally a 'unified' approach, Alternative X is vulnerable to having either component cut or deferred. If the EOEA Data Center or the DEQE Data Center is cut from the plan, the result is not attractive.

2. The IBM 4381 would be lightly used initially; it is unclear whether the EOEA workload excluding DEQE would soon justify the 4381-M11.

3. There are costs (and risks) associated with multiple vendors. There are also extra costs and planning problems associated with supporting two relational DBMS products.

5. Finally, while DEC, rather than IBM, is considered more likely to support the ultimate GIS system, Alternative X does not help EOEA acquire DEC or other GIS-style skills at the Data Center.

4.3.2 Alternative Y: Rapidly expand the EOEA Data Center to serve the Secretariat and all agencies centrally for the next 2-5 years as a mixed vendor center .

Alternative Y involves centralized computing but acknowledges that the requirements of future EOEA applications may differ from those best supported by IBM's DOS/VSE systems. While certain applications will make use of CICS, COBOL, etc., other applications will require end-user computing, office networking, and relational databases.

Alternative Y includes two complete systems, both located at the EOEA Data Center, and both serving all of the EOEA agencies. For planning purposes, Alternative Y includes an IBM 4381-M11 for "transaction processing" and "batch" support, with pass-through access to BCS. In the same EOEA computer room, Alternative Y also installs a DEC VAX 8500; this will support office, end-user and scientific/analytic applications. Users have easy access to either system.

While Alternative Y includes the same products as Alternative X, the location and governance of the DEC equipment are different. Details are provided in Appendix A.

The advantages of Alternative Y are:

1. Operating only one computer center reduces the need for staff and supplies, and simplifies network management.

2. Providing them centrally makes VAX-like computing and relational database facilities available to all EOEA agencies. However, since DEQE has the most urgent needs, DEQE applications would likely be the first to be brought up on the expanded EOEA Data Center.

3. DEQE databases could be more easily accessed and shared than would be the case with Alternative X; note, however, that access by other agencies to future DEQE applications may not need to be frequent or detailed.

4. Having both IBM and DEC (or others) in the EOEA Data Center may spur competition and responsiveness.

5. The strengths and capabilities of both environments (IBM for transaction processing, DEC for office/analytic) are available to all EOEA users. Users get whichever is better for a given application

The disadvantages of Alternative Y are:

1. Supporting two hardware and software environments is costly: in staff, duplicate software, etc.

2. There is perhaps a greater risk of delay in meeting their near-term DEQE database milestones, since DEQE or its contractors will be dependent on the EOEA Data Center rather than on its own data center.

3. There is greater dependence on data communications between DEQE at Winter Street and the EOEA Data Center. NYNEX has not responded well to past problems. Future problems would disrupt urgent DEQE priorities.

4.3.3 Alternative Z: Expand the EOEA Data Center rapidly as a centralized, single vendor site.

This would involve a large computer at the EOEA Data Center (say an IBM 4381-12, configured to support about 120 simultaneous users). New IBM and IBM-compatible software would be established to better match the future EOEA workload mix. Likely software would be the VM/SP time-shared operating system, with DOS/VSE as a 'guest' (running under VM), and a relational database system (also under VM, say ADABAS).

Office communications would not be directly supported by the central machine. Instead, three separate LANs would be included, each with its own file servers. PC users on any of these networks could access the central system.

The advantages of Alternative Z are:

1. It combines a single computer center with a single vendor and a single software environment. This simplifies staffing and reduces facility and software costs.

2. Conversion to VM would be relatively easy for the Data Center (VM is already installed but not much used at the Data Center).

3. VM is a better 'fit' than DOS/VSE for the future mix of EOEA computing.

4. All software capabilities are available to all users.

5. In general, Alternative Z has the lowest dollar cost of the four alternatives studied.

The disadvantages of Alternative Z are:

1. It provides no progress toward the goal of departmental processing under departmental control.

2. DEQE remains highly dependent on the EOEA Data Center for operations and development. (In trying to serve everyone, the EOEA staff may be less responsive to any single agency's needs and priorities)

3. The RDBMS products under VM are less mature and market-tested than those under non-IBM environments.

5. Services to DEQE depend on NYNEX telecom links, which have a history of unreliability (as with Alternative Y).

6. Even under VM, IBM mainframes are not presently a strong contender for the eventual GIS system. Therefore, Alternative Z does not give users or EOEA technical staff a 'headstart' in the GIS direction.

4.3.4 Alternative W: Create a distributed network immediately, with the EOEA Data Center specializing in complex or shared databases and tools such as GIS, while department-level computing specializes in office automation and end-user computing.

This is a 'hybrid' of Alternatives X and Y. It involves centralized computing (budgeted as a DEC VAX 8500) plus departmental computers (a VAX 8200 and MicroVAX IIs). The departmental computers would be compatible with the central system (and networked via DecNet), but would not support complex applications development at this stage of building the overall network; they would be used instead to support highly-responsive office automation.

Alternative W includes three hardware acquisitions:

1. **First, the EOEA Data Center will install a replacement IBM 4361 to stabilize current processing.**

2. **Next, the EOEA Data Center will acquire an analytic/end-user computer (budgeted as a DEC VAX 8500) and a relational database management system (budgeted as ORACLE).** This system will support all EOEA agencies.

3. **Finally, Alternative W calls for departmental processors at DEQE and at 100 Cambridge Street.** These will be compatible with the central (DEC) system, and will be dedicated initially to office automation. The 100 Cambridge Street system (budgeted as a MicroVAX II serving a LAN such as DecNet) will support EOEA headquarters, the Department of Food and Agriculture, and the Department of Environmental Management. The DEQE system (budgeted as a DEC VAX 8200) will support the office and communication needs of a larger network at DEQE.

The advantages of Alternative W are:

1. By selecting all systems together, compatibility is assured. The office automation and database work are planned from the beginning to fit together.

2. Office and communications processing at DEQE should be highly responsive. DEQE will not be dependent on the workload at the EOEA Data Center or the reliability of the Winter Street/Somerset Street links.

3. Departmental systems at DEQE and 100 Cambridge Street will initially require little operations or technical support, since their role is limited to network servers. These systems can later grow to serve more complex distributed processing applications.

4. The use of DEC (or similar analytic/end-user oriented products) makes it likely that the system will be compatible with future GIS directions.

5. **Technical skills and databases developed first for DEQE will be readily available to all EOEA agencies.**

6. Office networking will be available to all agencies (with the MDC supported by the Data Center VAX), not just to DEQE.

7. The roles for the data centers are specialized and do not involve a duplication of software or skills. The EOEA Data Center will have the most sophisticated support for databases, systems development, network management, and operations. The departmental centers will not require full-time operational staffs, focusing instead on end-user and communications support.

The disadvantages for Alternative W are:

1. DEQE is less in control of its own destiny than under Alternative X. While Alternative W gives DEQE its own office automation and networking facilities, database applications (by DEQE or its contractors) will rely on the EOEA Data Center.

2. DEQE must rely on the heretofore unreliable Winter Street to Somerset Street communications link for applications processing. This link must be improved for this alternative to work well.

3. The chosen vendor and technology is likely to be new to the EOEA Data Center staff. Consequently, relative to Alternative Z, delays may be required for learning.

4. The simultaneous specification and selection of compatible products for the EOEA Data Center and departmental LANs may be more complex than if they were selected separately. The 'best' overall vendor may be sub-optimal in some specific requirement, and the acquisition process may be more time-consuming.

4.4 SUMMARY ANALYSIS AND RECOMMENDATION

After several sessions on the alternatives, the Data Policy Group recommended Alternative W. This was presented to and ratified by the Information Technology Planning Group. The following are the compelling advantages of Alternative W:

1. **Alternative W has strong support from agencies and the Data Policy Group.** It reflects an attractive combination of Alternative X (data centers at both DEQE and EOEA) and Alternative Y (multi-vendor access at EOEA). Such support is important. All alternatives could be made to work in a pure technical sense. The important element (as with most information technology plans) is the degree of organizational commitment they can command.

2. **Alternative W supports DEQE's urgent development priorities.** It makes a large-scale computing system available, as the VAX 8500 is larger than DEQE's needs alone could likely justify. It also funds outside contractors for DEQE systems development; DEQE systems could even be developed outside on a time-shared basis if the in-house EOEA machine is delayed.

3. **This plan gives early support for office automation and networking.** Office automation provides a high-payoff, low-risk direction. This plan assures inter-agency compatibility in office automation and communications (e.g., it will be easy to send messages from the MDC to DEM).

4. **This plan also provides a serious first step for agency-level computing.** It puts machines, software, and analysts directly into user departments.

5. **Finally, Alternative W recognizes the importance to EOEA of a diverse mix of computing applications.** Alternative W comfortably supports transaction processing, PCs, LAN-level communications, analytic/end-user computing, complex databases, and the promise of future GIS.

The analysis of alternatives is summarized in Table 4.1.

Table 4.1
Summary of Options

---Impacts & Criteria	Options------- W	X	Y	Z
	(measures and/or subjective)			
2-yr $ hardware	1165	912	887	701
2-yr $ software	336	541	487	301
2-yr $ contract	742	642	636	543
2-yr $ New (thous.)*	2243	2095	2010	1545
EOEA staff	12	4	9	4
Agency staff	5	8	1	3
Total	17	12	10	7
IBM access	ALL	ALL	ALL	ALL
DEC access	ALL	DEQE	ALL	NONE
OA access	ALL	mixed	ALL	IBM's
RDBMS access	ALL	mixed	ALL	IBM's
GIS headstart	more	some	more	less
Computing mix	good	fair	good	poor
Ease of conversion	fair	good	fair	best
Implementation time	2 yr	2 yr	2 yr	< 2 yr
External support	good	fair	fair	fair
Fallback strength	good	poor	fair	poor

* 2-yr costs estimated as .5 * one-time costs + 2 * annual costs.

Chapter 5: Recommended Plan of Action

This chapter presents the plan of action recommended by the Information Technology Task Force. The plan addresses hardware and staff, and then the support needed for database, office automation, personal computing, geographic information systems, and strategic planning. (Additional detail appears in Appendix B.)

5.1 HARDWARE AND STAFF

The plan requires four new computers and 17 new staff.

5.1.1 Hardware.

Two of the new computers will reside in the EOEA Data Center at 20 Somerset Street. (The other two are departmental computers and described in Section 5.3.) One is a "caretaker" IBM and the other will support new applications.

1. **The caretaker replacement for the IBM 3031 will be a machine such as an IBM 4361-G5.** This will provide stability for today's IBM-based applications and will also reduce maintenance costs. The system should have at least 8 megabytes of main memory and an internal commercial speed of 1.1 MIPS; it need not be faster. The payback occurs in four years based on reduced maintenance costs alone (the 3031 costs about $39,000 per year more than a 4361 for maintenance); the payback is faster if allowance is made for improved reliability. Further, by stabilizing the IBM work, management attention can focus on the more important new database applications; if the present IBM environment is <u>not</u> stabilized, fire-fighting could endanger the schedule of the overall I-T program.

2. The system for new applications should support at least 80 simultaneous users and serve as the primary 'work horse' for EOEA's needs in the next five years.

The minimum requirements are:

- 12 megabytes of main memory
- Expansion to support 4 to 6 gigabytes of disk storage
- Internal MIPS rate (commercial mix) of 3 +
- Serious floating point support
- Multi-purpose, flexible operating system
- Access from IBM 3270 terminals possible (protocol translators OK)
- Ability to act as the central server for a small LAN that serves the MDC (perhaps 20 PCs/ workstations)

This machine was costed out as a DEC VAX 8500. (See Chapter 2, Section 2 for a summary of our judgments on sizing.)

5.1.2 Staff

Seventeen new staff are required:

1. **Information Technology Manager for EOEA.** This will be a new agency-level manager, to whom the operations-oriented Data Center manager will report. This manager should be responsible for applications, priorities and data standards. He or she will also develop the agenda and materials for the Data Policy Group.

2. **2 EOEA applications developers for conventional (non-database) applications.** These are needed at the Data Center.

3. **1 EOEA staff for LAN administration and operations.** This person will provide Secretariat-wide support for LAN and communications activities.

4. **3 EOEA technical staff (systems programmers, network support).** They will work with the DEC or other newly acquired system.

5. **2 EOEA support staff for Secretariat-wide PC training and support.** These will support users but will not assist in major applications development.

6. **2 DBMS development managers.** One will work at EOEA as overall EOEA database administrator and developer for non-DEQE applications. The other will work at DEQE.

7. **1 EOEA staff for Geographic Information Systems.** This person will monitor developments at other agencies, develop EOEA plans and requirements, and supervise projects such as those with the USGS and contractors.

8. **5 support staff for end-user computing and database design/administration.** Two for DEQE and one each for the MDC, DEM and EOEA (for other agencies).

5.2 DATABASE APPLICATIONS

The EOEA Data Center will support a database management system. This tool should be selected to include the following capabilities:

- Multi-user with simultaneous updating, record locking
- Program interfaces (e.g., FORTRAN) and end-user query and development languages
- Relational design philosophy
- Support of floating point as a data type
- Support of SQL, an emerging query interface standard, (desirable but not required)
- Efficient in support of smaller or less complex databases (20,000 - 50,000 records)
- Journaling, restart-recovery, and support for transaction update integrity

For budgetary purposes, the ORACLE product has been used. Other vendor offerings also meet these requirements.

Specific projects are planned which will utilize this database development tool.

1. **DEQE will build a Facilities Master File.** This will identify each facility in Massachusetts involved in the Right-to-Know program, hazardous waste program, or water/air permitting program. The Facility Master File will support multiple applications, including Hazardous Waste Manifest Tracking, SSEIS, and Right-to-Know, when and as they are converted to the new database environment. As a database application, the Facilities Master File will permit more flexible analysis than before (for example, it will be much easier to get answers to questions such as "what are the problem facilities in Dartmouth (where the 'problem' can be with any of the above programs)?")

2. **DEQE plans a series of major applications in support of the Question 4 hazardous waste cleanup programs.** These are in the early planning stage, but will be complex initiatives with demanding schedules. As they will serve to guide a $250 million clean-up program, the investment required should be easy to cost-justify.

3. **EOEA plans to build several multi-agency databases to coordinate land use -- state and federal parks, properties, acquisition programs, etc.** These databases need not have sophisticated mapping or geo-coordinate search capabilities.

4. **EOEA also plans to design and build a cities and towns database.** This will identify EOEA-wide initiatives, projects, and enforcement actions. Such databases answer important questions (e.g., "What have you done for us lately?"). They tend to become essential once staff learn to use them ("How did we get along without it?").

5.3 OA AND COMMUNICATIONS SUPPORT

Office automation and communications will require two departmental processors, one at DEQE and another at 100 Cambridge Street. These will be compatible with and networked to the EOEA Data Center. The DEQE system (planned as a DEC VAX 8200) will work as the central file server for a LAN that contains at least 80 PC workstations; it will thus provide shared access to printers, files, and

communications to the EOEA, EPA, and other outside services. The system at 100 Cambridge Street (planned as a MicroVAX II) will be the central file server for a LAN of at least 30 PC workstations. Staff at the EOEA Data Center will administer and monitor these networks, and will also support PC applications development.

5.4 PERSONAL COMPUTING

The Data Policy Group endorses the continued expansion of personal computers for word processing, personal computing, and small databases. Alternative W includes funds to accelerate the acquisition of PCs by about 20 units per year in each of two years, or by $200,000 in total (assuming $5,000 for each fully-configured PC) (The staff associated with supporting this initiative were identified above in Section 5.1.)

The MDC has more locations than other agencies and only limited use of PCs. Accordingly, we recommend giving high priority for PCs to those MDC locations that are not likely to be connected to the 20 Somerset Street LAN. (Of course, each PC installation must be justified and evaluated on its own merits.)

5.5 GEOGRAPHIC INFORMATION SYSTEMS

The Data Policy Group endorses the concept of developing EOEA capabilities for managing geographic-based data. This includes the acquisition of tools for co-ordinate search, detailed and large-scale mapping, color plotting, and layering.

However, since the state of the art is evolving and new vendor products are expected, GIS requirements have not been incorporated into the current system specifications (either for computing workload or required software and peripherals.)

The Alternative W program does include a higher level of GIS development work, joint projects with vendors and/or other agencies, and the conversion of data from maps; it does not include the acquisition of an in-house system during the first 24 months. To support the planned GIS work, we recommend that EOEA hire a GIS coordinator/planner. Our proposal budgets $300,000 in contractor work for this period.

5.6 STRATEGIC INFORMATION SYSTEMS PLANNING

In this study, the Data Policy Committee did not have the resources to systematically address all EOEA programs or targets for information technology. There are undoubtedly other high-payoff applications.

The new Information Technology Manager and the Data Policy Group will need support in identifying and prioritizing these applications. The Alternative W program includes $80,000 for such planning.

History -- brief as it has been in the information technology field -- has shown that the "winners" recognize the imperative for management education and planning. The wise use of information technology is a problem whose essence is not technical, but managerial. Those who take the technology seriously must also take planning seriously.

* * * * *

The above information technology plan is the result of nearly six months of staff analysis and discussion. It is an aggressive but workable plan. Its success will provide immediate support for improved environmental management and will also help build the infrastructure for the technology-intensive future which lies ahead.

Appendix A: Details of Rejected Alternatives

ALTERNATIVE X: BOTH EOEA AND DEQE NOW

I. Actions

HARDWARE AND SOFTWARE

- IBM and Intelligent Switch at EOEA Data Center, DEC mainframe at DEQE
- DBMS first at DEQE Data Center, later at EOEA Data Center.
- OA/LANs, file servers at DEQE, others (120 users)
- PCs at departments

STAFF AND GOVERNANCE

- Staff expansion and training at EOEA, Data Center
  - EOEA I-T Manager
  - Staff for operations, network support (1)
  - Staff for End-user DBMS, development (1)
  - Staff for PC support (1)
- Staff expansion for DEQE
  - Staff for operations (5)
  - Staff for End-user DBMS, development (2)
- Systems analyst for one non-DEQE department
- Contract work:
  - DEQE Facilities Master File
  - DEQE Question #4 work
  - GIS feasibility, experimentation
  - Other?

USER CAPABILITIES/RESTRICTIONS

- Capabilities of both vendors available to all agencies, but operating and development access to DEQE Data Center controlled by DEQE.

ALTERNATIVE X: BOTH EOEA AND DEQE NOW
(Continued)

II. Budgetary Increments (Base + Modest)

Steps	Description ----------	2-yr Costs/Comments*
BAS:1	**Status quo**	**$2,720,000** Demoralizing
BAS:2	**Stabillze procedures/staff:** - 1 EOEA IS Manager - 2 Data Center staff	**$260,000**
INADEQUATE I-T SUPPORT AT THIS LEVEL		**$2,980,000/2-yr**
MOD:1	**HW upgrade:** - IBM 4361-5 (caretaker) - DEC VAX 8200 - 5 staff, training	**$680,000** Staff key (to cover 2 shifts @ DEQE)
MOD:2	**DBMS modest:** - on VAX (End-user oriented - 2 development staff at DEQE - contractor for DEQE - DEQE Facilities Master File	**$360,000** E.g., ORACLE, builds analysis capability
MOD:3	**OA/LAN modest:** - 3 LANs, file servers - 1 Support Staff at EOEA - 40 users @ DEQE - 30 users elsewhere	**$185,000** Easy, important; VAX as file server; E-mail transfers?
MOD:4	**Modest GIS plans,** (contractor oriented)	**$200,000** Strategic for longer-term
MOD:5	**Accelerate PC growth, User Support** - 1 Staff at EOEA Data Center - 20 PCs/yr above present rate	**$190,000** Easy, important
MODEST I-T SUPPORT, SHORT OF NEEDS		**$1,615,000** increment
TOTAL INCLUDING BASELINE FOR MODEST		**$4,595,000**

* Note: The original analysis focused on 2-year costs as presented here. These numbers cannot be directly compared to the costs in Exhibit 1.3, pp. 15-16.

ALTERNATIVE X: BOTH EOEA AND DEQE NOW
(Continued)

II. Budgetary Increments (Bas + Mod + Aggressive)

Steps	Description ----------	2-yr Costs/Comments
BASE-LEVEL SUPPORT		$2,980,000/2-yr
INCREMENTAL SUPPORT TO MODEST LEVEL		$1,615,000/2-yr
AGG:1	**Expanded HW:** - IBM 4381-11 (80 users) - DEC VAX 8500 (60 users)	**$600,000** increment (if invested from start; else more)
AGG:2	**DBMS expansion:** - RDMS on IBM - 2 development staff at EOEA - EOEA backlog - other applications??	**$225,000** cross-agency needs require analysis
AGG:3	**OA/LAN expansion:** - next 50 users	**$75,000** Easy, important
AGG:4	**GIS expansion** - contractor - 1 EOEA employee	**$100,000**
AGG:5	**Strategic MIS planning**	**$80,000** Developing the big-impact options
AGGRESSIVE SUPPORT TO MEET NEEDS		$1,080,000 increment
TOTAL NEW RESOURCES (Mod + Aggressive)		**$2,695,000**
INTERNAL CONTRIBUTION FROM EOEA/DEPTS		**$ 600,000**
	NET NEW RESOURCES REQUESTED	$2,095,000 (2 yrs)
GRAND TOTAL		**$5,675,000**

ALTERNATIVE X: BOTH EOEA AND DEQE NOW
(Continued)

III. Pros and Cons

PROS

(+) Modest transition for Data Center staff; minimal conversion risk, disruption.

(+) DEQE responsible for own success with Facilities Master File and urgent Prop-4 requirements.

(+) VAX in same building as most DEQE network users, can function as a file server.

(+) Outside contractors support speed-up if internal expansion can't meet time-table.

CONS

(-) Nominally "unified", but either major component easily cut or deferred by A&F, DCPO or Legislature.

(-) Unclear if other agency workloads justify capacity of large 4381, if all DEQE processing removed.

(-) Access to DEC available to non-DEQE agencies, but may be limited; priorities set by DEQE.

(-) DEC environment more likely than IBM to support ultimate GIS, although either (or neither) may be the ultimate winner; this alternative provides EOEA Data Center with little DEC familiarity.

(-) More complex management to develop specialized database skills at two locations simultaneously.

ALTERNATIVE Y: EOEA ONLY, MIXED VENDOR

I. Actions

HARDWARE AND SOFTWARE

- Closely linked IBM, DEC mainframes, Intelligent Switch at EOEA Data Center
- DBMS at EOEA Data Center; "mission" is GIS-like work first, DEQE first on.
- OA/LANs, file servers at DEQE, others (120 users)
- PCs at departments

STAFF AND GOVERNANCE

- Staff expansion and training at EOEA, Data Center
  - -- EOEA IT Manager
  - -- Staff for operations, network support (4)
  - -- Staff for End-user DBMS, development (3)
  - -- Staff for PC support (1)
- Systems analyst for DEQE, one other
- Contract work:
  - -- DEQE Facilities Master File
  - -- DEQE Question #4 work
  - -- GIS feasibility, experimentation
  - -- Other?

USER CAPABILITIES/RESTRICTIONS

- Capabilities of both vendors available to all agencies

ALTERNATIVE Y: EOEA ONLY, MIXED VENDOR

(Continued)

II. Budgetary Increments (Base + Modest)

Steps	Description ----------	2-yr Costs/Comments
BAS:1	**Status quo**	**$2,720,000** Demoralizing
BAS:2	**Stabilize procedures/staff:** - 1 EOEA IS Manager - 2 Data Center staff - Technical pay scale	**$260,000** Internally funded??
INADEQUATE I-T SUPPORT AT THIS LEVEL		$2,980,000/2-yr
MOD:1	**HW upgrade:** - IBM 4361-5 (caretaker) - DEC VAX 8200 - 3 staff, **training**	**$580,000** Staff, training key
MOD:2	**DBMS modest:** - on VAX (End-user oriented, may grow to GIS) - 2 development staff at EOEA - contractor for DEQE - DEQE Facilities Master File - some EOEA backlog and planning	**$360,000** E.g., ORACLE, builds analysis capability
MOD:3	**OA/LAN modest:** - 3 LANs, file servers - 1 Support Staff at EOEA - 40 users @ DEQE - 30 users elsewhere	**$200,000** Easy, important
MOD:4	**Modest GIS plans, experimentation** (contractor oriented)	**$200,000** Strategic for longer-term
MOD:5	**Accelerate PC growth, User Support** - 1 Staff at EOEA Data Center - 20 PCs/yr above present rate	**$190,000** Easy, important
MODEST I-T SUPPORT, SHORT OF NEEDS		**$1,530,000 increment**
TOTAL INCLUDING BASELINE FOR MODEST		**$4,510,000**

ALTERNATIVE Y: EOEA ONLY, MIXED VENDOR
(Continued)

II. Budgetary Increments (Bas + Mod + Aggressive)

Steps	Description ----------	2-yr Costs/Comments
BASE-LEVEL SUPPORT		$2,980,000/2-yr
INCREMENTAL SUPPORT TO MODEST LEVEL		$1,530,000/2-yr
AGG:1	**Expanded HW:** - IBM 4381-11 (80 users) - DEC VAX 8500 (80 users)	**$600,000** increment (if invested from start; else more)
AGG:2	**DBMS expansion:** - RDMS on IBM - 1 development staff at DEQE - 1 development staff at EOEA - EOEA backlog, others??	**$225,000** (less if keep on one machine); cross-agency needs require analysis
AGG:3	**OA/LAN expansion:** - next 50 users	**$75,000** Easy, important
AGG:4	**GIS expansion** - contractor - 1 EOEA employee	**$100,000**
AGG:5	**Strategic MIS planning**	**$80,000** Developing the big-impact options
AGGRESSIVE SUPPORT TO MEET NEEDS		$1,080,000 increment
TOTAL NEW RESOURCES (Mod + Aggressive)		**$2,610,000**
INTERNAL CONTRIBUTION FROM EOEA/DEPTS		**$ 600,000**
NET NEW RESOURCES REQUESTED		**$2,010,000** (2 yrs)
GRAND TOTAL		**$5,590,000**

ALTERNATIVE Y: EOEA ONLY, MIXED VENDOR

(Continued)

III. Pros and Cons

PROS

(+) One site means reduced need for operating staff, network management.

(+) Supports DEQE (via budget, staff, contracts), but allows easier sharing with others (espcially for GIS-like databases).

(+) Mixed vendor keeps competition until GIS future clearer

IBM: transaction processing, batch
DEC: analytic, modelling, end-user and office communications support

(+) Outside contractors support speed-up if internal expansion can't meet time-table.

CONS

(-) Requires EOEA Data Center to learn a new vendor in addition to developing DBMS and End-User Support skills (added systems software, risk of delay).

(-) Central staff serves all, therefore less responsive to any single agency.

(-) Must develop adequate network capacity to handle load between Winter St and Data Center (NYNEX T1, microwave, cable?).

ALTERNATIVE Z: EOEA ONLY, SINGLE VENDOR

I. Actions

HARDWARE AND SOFTWARE

- Moderate to large IBM mainframe under VM/SP, with VSE as guest operating system.
- End-user oriented DBMS at EOEA Data Center.
- OA/LANs, file servers at DEQE, others (120 users).
- PCs at departments.

STAFF AND GOVERNANCE

- Staff expansion and training at EOEA, Data Center
  - -- EOEA IT Manager
  - -- Staff for network support (1)
  - -- Staff for End-user DBMS, development (3)
  - -- Staff for PC support (1)
- Systems analyst for DEQE, one other
- Contract work:
  - -- DEQE Facilities Master File
  - -- DEQE Question #4 work
  - -- GIS feasibility, experimentation (contract)
  - -- Other?

USER CAPABILITIES/RESTRICTIONS

- Full capabilities of IBM (or other selected vendor) available to all agencies

ALTERNATIVE Z: EOEA ONLY, SINGLE VENDOR

(Continued)

II. Budgetary Increments (Base + Modest)

Steps	Description ----------	2-yr Costs/Comments
BAS:1	**Status quo**	**$2,720,000** Demoralizing
BAS:2	**Stabilize procedures/staff:** - 1 EOEA IS Manager - 2 Data Center staff - Technical pay scale	**$260,000** Internally funded??
INADEQUATE I-T SUPPORT AT THIS LEVEL		**$2,980,000/2-yr**
MOD:1	**HW upgrade:** - IBM 4381-1 - **training**	**$320,000** save on staff, training
MOD:2	**DBMS modest:** - on IBM (End-user oriented, may grow to GIS) - 2 development staff at EOEA - contractor for DEQE - DEQE Facilities Master File - some EOEA backlog and planning	**$360,000** E.g., ORACLE, NOMAD, FOCUS; builds analysis capability
MOD:3	**OA/LAN modest:** - 3 LANs, file servers - 1 Support Staff at EOEA - 40 users @ DEQE - 30 users elsewhere	**$200,000** Easy, important
MOD:4	**Modest GIS plans, experimentation** (contractor oriented)	**$200,000** Strategic for longer-term
MOD:5	**Accelerate PC growth, User Support** - 1 Staff at EOEA Data Center - 20 PCs/yr above present rate	**$190,000** Easy, important
MODEST I-T SUPPORT, SHORT OF NEEDS		**$1,270,000 increment**
TOTAL INCLUDING BASELINE FOR MODEST		**$4,250,000**

ALTERNATIVE Z: EOEA ONLY, SINGLE VENDOR
(Continued)

II. Budgetary Increments (Bas + Mod + Aggressive)

Steps	Description ----------	2-yr Costs/Comments
BASE-LEVEL SUPPORT		$2,980,000/2-yr
INCREMENTAL SUPPORT TO MODEST LEVEL		$1,270,000/2-yr
AGG:1	**Expanded HW:** - IBM 4381-12 (120 users)	**$500,000** increment? (if invested from start; else more)
AGG:2	**DBMS expansion:** - 1 development staff at DEQE - 1 development staff at EOEA - EOEA backlog - **other applications???**	**$120,000** cross-agency needs require analysis
AGG:3	**OA/LAN expansion:** - next 50 users	**$75,000** Easy, important
AGG:4	**GIS expansion** - contractor - 1 EOEA employee	**$100,000**
AGG:5	**Strategic MIS planning**	**$80,000** Developing the big-impact options
AGGRESSIVE SUPPORT TO MEET NEEDS		$875,000 increment
TOTAL NEW RESOURCES (Mod + Aggressive)		**$2,145,000**
INTERNAL CONTRIBUTION FROM EOEA/DEPTS		**$ 600,000**
	NET NEW RESOURCES REQUESTED	**$1,545,000** (2 yrs)
GRAND TOTAL		**$5,125,000**

ALTERNATIVE Z: EOEA ONLY, SINGLE VENDOR

(Continued)

III. Pros and Cons

PROS

(+) One site, one vendor means minimal need for operating staff, network management; if IBM the selected vendor, then minimal conversion from present systems.

(+) Supports DEQE (via budget, staff, contracts), but allows easier sharing with others (espcially for GIS-like databases).

(+) Program cannot easily be split.

(+) Outside contractors support speed-up if internal expansion can't meet time-table.

(+) Under Aggressive program, have adequate capacity to eventually bring in-house work now done at Regents/UMass.

CONS

(-) No headstart on GIS-like capabilities, potential sub-optimal choice on analytic/communications applications (assuming IBM the vendor).

(-) Central staff serves all, therefore less responsive to any single agency.

(-) Must develop adequate network capacity to handle load between Winter St and Data Center (NYNEX T1, microwave, cable?).

Appendix B: Cost Details - Recommended Program

This appendix describes assumptions and cost estimates for the recommended program. One-time and annual cost estimates are made for staffing, hardware, software, and contract work.

Costs in summary are as follows:

Table B.1
Costs of Recommended Program
($ in 000s)

Class	One-time	Annual
Staffing	$0	$455
Hardware	1,283	162
Software	210	34
Contracted	860	n/a
Total	$2,353	$651

B.1 STAFFING

As detailed in 5.1, the recommended program requires 12 new staff for EOEA plus 5 in the agencies -- MDC, DEQE and DEM.

Although the new Information Technology Manager is a senior position, others are technical and support positions. The new positions have been budgeted at an average of $30,000/year. This is intended to reflect overhead costs, but also the reality that most positions will not be filled immediately.

Table B.2
Staff Requirements for Recommended Program

Department	Staff	Annual
EOEA	12	$305,000
DEQE	3	90,000
DEM	1	30,000
MDC	1	30,000
Total	17	$455,000

For the first two years, the total added staff costs are estimated to run $910,000; this is perhaps a high estimate due to delays likely in hiring.

B.2 HARDWARE CHANGES

Four different computers are recommended -- a replacement IBM, a central EOEA general-purpose system, and two departmental computers for office automation/networking. In addition, we recommend an accelerated use of personal computers. For budgetary purposes, we selected specific configurations as described below.

Net hardware costs are as follows:

Table B.3
Hardware Costs of Recommended Program

Component	One-Time	Annual
IBM caretaker	$232,000	($39,000)
Central VAX 8500	729,000	59,000
DEQE VAX 8200	282,000	30,000
100 Camb MV II	40,000	12,000
Personal computers	n/a	100,000
Total hardware	$1,283,000	$162,000

Note that personal computer costs are additions above current levels and are expensed.

Appendix C presents details of the replacement IBM system; we budget it as a used 4361-G5 with used (but newer than the current) disks and tapes. Annual maintenance cost will be about $39,000 per year below current maintenance. While this may not justify a one-time $232,000 outlay on its own, we believe that the net added cost is reasonable to get a reliable, capable mainframe system during the acquisition and transition period; if the IBM 3031 applications are not stabilized, they will require 'fire-fighting' which may disrupt and delay the implementation of higher priority programs.

B.3 SOFTWARE CHANGES

Software costs are estimated as follows:

Table B.4
Software Costs of Recommended Program

Component	One-Time	Annual
IBM replacement	$0	$0
Central VAX 8500	180,000	22,000
DEQE VAX 8200	10,000	4,000
100 Camb MV II	20,000	8,000
Personal computers	n/a	n/a
Total software	$210,000	$34,000

The replacement IBM will use the same software as today's IBM 3031, at no added cost. Costs for the MicroVax II software (used as a LAN file server at 100 Cambridge Street) are estimated. Software costs for the personal computers were included in the hardware estimates.

B.4 CONTRACTOR EXPENDITURES

Three contractor efforts have been budgeted. They total $860,000 as follows:

Table B.5
Contractor Costs for Recommended Program

Contractor Project	Cost
DEQE database, applications development	$480,000
EOEA Geographic Info Sys development	300,000
EOEA Strategic Information Sys planning	80,000
Total Costs	$860,000

Note that our budget does not include Question 4 work; that work, while still in the early design stages, is expected to be a significant expense.

Appendix C: Configurations

This appendix provides detail on hardware and software configurations, along with price estimates.

Four configurations are presented:

1. Today's IBM 3031 system at the Data Center
2. A proposed IBM 4361-G5 'caretaker' replacement
3. A DEC VAX 8200 (configured as DEQE's office network server)
4. A DEC VAX 8500 (configured as Data Center primary system)

The one-time (hardware and software) and ongoing annual costs:

Table C.1
Cost of Configurations

System	Purchase	Annual
Current IBM 3031	n/a	$138,648
Replacement IBM 4361-M5	$232,000	$100,140
DEC VAX 8200	$291,315	$29,796
DEC VAX 8500	$909,000	$58,908
Total	$1,432,315	$327,492

As noted in Chapter 4, the use of specific products is intended to support budgeting; it does not imply that these products are the only means, or the preferred means, of fulfilling EOEA's needs.

The configurations presented here use list prices (or, in the case of used equipment, informal quotes or estimates as of early 1987). Prices are subject to discount and change. Minor components may have been overlooked or budgeted only in the aggregate. Specific warranties, installation charges, and vendor allowances are not reflected, nor are supplies, HVAC or electrical improvements (if any), or site preparation and cabling for networks.

C.1 CURRENT DATA CENTER CONFIGURATION

Today's hardware at the EOEA Data Center is 100% owned by the Commonwealth, so there are no rental or leasing charges. Because of the extreme age of some IBM and Storage Technology components, however, hardware maintenance costs are currently more than $80,000 per year. In addition, EOEA has not taken advantage of IBM's new variable systems software prices; these require a large one-time outlay but eliminate most monthly software charges. Annual software charges to IBM and other suppliers are now about $58,000.

Table C.2
Current Data Center Costs

Hardware Component	Monthly
IBM 3031 CPU	$2,663
STC 8880 disk controller	374
STC 8650 disks (3A, 1B)	1,034
IBM 3203-5 line printer, 1200 lpm	677
IBM 3705-E07 communications controller	338
IBM 2501 card reader	(SEE NOTE)
IBM 1442 card punch	(SEE NOTE)
IBM 3420-3 tape drivers (4)	1,356
IBM 3083 tape control unit	148
IBM 3274-21D terminal control unit	95
Total Hardware	$6,685

Table C.2
Current Data Center Costs
(continued)

Software Component	Monthly
VM/SP, SMART, ISPF, IPF	$639
DOS/VSE, CICS, ICCF	1,710
NCP/VTAM	306
COBOL compiler	184
FORTRAN VS compiler	249
DL/1	459
RPG II	160
Utilities	108
DMS/CICS	220
SPSS	417
IMAGINE	417
Total Software	$4,869
TOTAL Hardware plus Software	$11,554
Annualized Monthly Cost	$138,648

Note that the punch card reader and punch are being phased out and will be dropped from maintenance sometime in 1987. Not included above are user terminals (3270s and ITT equivalents), data prep card punches, and user datacomm controllers (IBM 3274 and equivalent).

C.2 REPLACEMENT IBM 4361-G5

An IBM 4361-G5 is designed as a replacement of the IBM 3031 system. No changes in software, terminals, printers, or communications network are included.

Table C.3
Replacement IBM Cost

Hardware Component (new)	Monthly	One-Time
IBM 4361-Group 5 CPU (Used) (includes 8MB memory, channels, and integrated disk/comm controllers)	$804	$50,000
IBM 3380-D disk drives, ctrl (6, used)	1,500	150,000
IBM 3420-7 tape drives, ctrl (4, used)	400	32,000
Total New Hardware	$2,704	$232,000
Hardware Component (existing)		
IBM 3203-5 line printer	677	
IBM 3274-21D control unit	95	
Total Hardware	$3,476	$232,000
Total Software (unchanged)	$4,869	
TOTAL Hardware plus Software	$8,345	$232,000
Annualized Monthly Cost	$100,140	

Software is estimated as unchanged from the current IBM, since no new capabilities are required. Prices for used equipment are estimated from general experience; ability to use IBM 3880-D disk drives with the 4361-M5 must be validated by IBM.

The substitution of old, used IBM equipment to replace even older IBM and STC equipment results in annual savings of

$$12 * (\$6,685 - \$3,476) = \$38,508$$

for hardware maintenance, but no significant increase in capacity. Use of a new IBM 9370-M40, and taking advantage of the new IBM graduated purchase prices on system software, could result in even greater savings.

C.3 DIGITAL VAX 8200 SYSTEM

The DEC VAX 8200 is designed to support DEQE office automation and a network at 1 Winter Street, and to provide external gateways. It is not sized or equipped for serious applications development or production.

Table C.4
VAX 8200 Cost

Hardware Component	Monthly	One-Time
VAX SV-82EPA-GK package, includes: - 8200 CPU, 8 MB memory - one KB50 disk controller - one RA60 disk - two RA81 disks - VMS and DecNet software	$837	$173,000
One TU82 tape drive - 75 inches / second - 6250 bpi density	167	27,500
One LP32 band printer	179	13,600
One LN01 laser printer	420	19,995
VT220 CRT terminals (20)	280	17,600
Cables, cabinets, misc.	300	30,000
Total Hardware	$2,183	$281,695

Software Component	Monthly	One-Time
VMS and DecNet (included above)	$0	$0
DECNET/SNA Gateway (EPA access)		3,120
DECNET/SNA printer emulation		1,560
Bisync terminal support		2,340
Ethernet terminal server		1,000
Office and other software not identified		16,000
Software support charges (estimated)	300	
Total Software	$300	$9,620
TOTAL Hardware plus Software	$2,483	$291,315
Annualized Monthly Cost	$29,796	

NOTES:

1. Software maintenance costs are estimated at 12% of the initial price. (DEC offers various alternatives for software support.)

2. PCs or workstations might sensibly be substituted for the VT200 terminals, but some dumb terminals will be needed.

3. The VAX 8200 configuration does not include development languages (e.g., COBOL or FORTRAN), since major applications will reside on the EOEA VAX 8500.

C.4 DIGITAL VAX 8500 SYSTEM

The DEC VAX 8500 is planned for the EOEA Data Center, and will be the primary general purpose system supporting batch, timeshared, and on-line computing. It will also act as a server for a local area network supporting MDC personal computers.

Table C.5
VAX 8500 Cost

Hardware Component	Monthly	One-Time
DEC system 851-BA-DE, includes - 8500 CPU, 20 MB memory - disk controller - VMS and DecNet software - one RA81 disk (456 MB)	$800	$299,000
3 additional RA81 disks	338	50,000
One TU82 tape drive, controller	167	27,500
Four RA81s, controller	452	68,000
DMB32 8 line comm controllers (5)	200	16,750
VT220 CRTs (twenty)	280	17,600
LG02 graphics matrix printers	152	14,000
LN01 laser printer	420	19,995
Other hardware not identified	300	36,000
Total hardware	$3,109	$548,845

Table C.5
VAX 8500 Cost
(continued)

Software Component	Monthly	One-Time
VMS and DecNet (included)	0	$0
DECNet/SNA Gateway (BCS access)		4,000
DECNet/SNA printer emulation		2,000
Bisync terminal support		3,000
Ethernet terminal server		1,000
FORTRAN		10,340
COBOL		15,950
Datatrieve, 4GL		13,200
Common Data Dictionary		2,640
ORACLE or similar RDBMS		80,000
All-in-One or similar (estimate)		24,000
Other software not identified		24,000
Software support costs (estimate)	1,800	
Total software	$1,800	$180,130
Total hardware plus software	$4,909	$728,975
Annualized Monthly Cost	$58,908	

NOTES:

1. Software support costs are estimated at 12% of the one-time outlay.

2. PCs or workstations might sensibly be substituted for the VT200 terminals, but some dumb terminals will be needed.

3. The cost of the ORACLE or similar DBMS is included under the DBMS program element, described in Chapter 5.